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ENGINEERING AND EQUIPMENT

No. 63

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USSR REPORT

ENGINEERING AND EQUIPMENT

No. 63

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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BRIEFS

MODEL OF LASER ENGINE--Moscow November 5 TASS--A model of a laser engine has been built by scientists of the Lebedev Institute of Physics, Academy of Sciences of the USSR. The source of energy in this engine is a laser beam. It heats up gas which, expanding, pushes the piston and thus sets the engine in motion. Expanded gas goes to the heat exchanger, and, while cooling, it is directed back to the place of origin. Inasmuch as a great amount of energy is concentrated in the laser beam, the conversion of gas into plasma and its expansion take place instantaneously. The scientists say that it is still early to speak of the practical application of the laser engine. But this model shows that th's is quite feasible. The mechanical force created by laser can, for instance, lift into the air an object weighing up to one kilogram and move it along at a speed of hundreds of metres a second. This was shown by experiments. Scientists believe that it will take a very powerful laser to make a workable engine. In the future it may be used to make an air jet engine for aircraft, a device for cargo delivery, and instruments for directing the movement of various objects. Soviet specialists believe that such engines will have considerable advantages. Specifically, they will not rpt not pollute the environment. The American researcher Ashk'n was the first to come up with the idea of using laser for designing an engine. He suspended only fractions of a gram in the laser beam. The Soviet scientists succeeded in holding in the air an object weighing one kilogram. [Moscow TASS International Service in Russian 1335 GMT 5 Nov 79]

CSO: 1861-F

USSR   UDC   533.6.12

A BOUNDARY LAYER WITH SELF-INDUCED PRESSURE AT A MOVING SURFACE

ZHUK, V. I. and RYZHOV, O. S., Computer Center, USSR Academy of Sciences,
Moscow

[Abstract] A nonsteady boundary layer with self-induced pressure is con-
sidered at a plane thermally insulated wall in a supersonic stream with up-
stream perturbations. The appropriate Navier-Stokes equations, in Cartesian
coordinates, are solved for such a boundary layer with the wall velocity as
a variable parameter. A solution is obtained, for illustration, in the case
of a weak shock wave generated by motion of a wedge above the boundary layer
and inducing a zone of free interaction. Various limiting and extreme condi-
tions are considered. The article was presented by academician A. A. Dorod-
nitsyn on 3 Apr 79. Figures 1; references 5 (Russian).
[420-2415]

USSR   UDC   536.24:534.22

DETERMINATION OF THE AMPLITUDE-FREQUENCY CHARACTERISTICS OF THERMOACOUSTIC OSCILLATIONS IN A FLUID UNDER SUPERCRITICAL PRESSURE

SINITSYN, A. G., Leningrad Mechanics Institute

[Abstract] The transfer of heat to a fluid under supercritical pressure in
the presence of supercritical temperatures at the wall and precritical tem-
peratures in the flow core is accompanied by high-frequency oscillations
(HFO) of the pressure. Calculations show that then a layer of fluid with a
low speed of sound is present in the neighborhood of the wall, and this re-
sults in a sharp increase in the velocity of secondary acoustic eddies as well
as in a marked intensification of heat exchange. Thus also the anomalous
improvement in heat transfer in this process is of acoustic origin. In this
connection, the characteristics of HFO in the presence of various flow parame-
ters are investigated on the basis of a nonlinear two-dimensional system
which includes hydro- and thermodynamic equations and describes the propa-
gation of waves in a plane channel. Averaging over the transverse coordinate

reduces the system to a one-dimensional one, and then functions allowing for thermal and dynamic interaction with the wall make their appearance. The nonlinear equation is solved in the form of a Fourier series, with the co-efficients being derived from a nonlinear homogeneous system of algebraic equations. The condition of existence of the solution determines the possible oscillation frequencies. A comparison of the theoretical and experimental findings on the amplitude and frequency of the thermoacoustic oscillations proved to be in good agreement. Figures 4; references 8: 7 Russian, 1 Western.
[409-1386]

OPTICAL INVESTIGATION OF THE ELECTRIC ARC IN A TURB LENT AIR FLOW

ZASYPKIN, I. M. and POPOK, N. I., Novosibirsk, Siberian Affiliate of the USSR Academy of Sciences

[Abstract] The structure of gas flow and the behavior of the arc along the channel in an axial-system plasmotron determine the interaction between the electric arc and the gas flow. In this connection, the electric arc in a plasmotron with a segmental interelectrode insert was investigated with the aid of a high-speed camera. Analysis of the photographs served to estimate the mean and fluctuational components of the rate of motion of the arc in the channel sectors with transient flow and with developed turbulent flow. It is shown that perturbations of the arc column move along the channel at the speed of the gas flow. The degree of turbulence of the gas flow in the channel sectors with transient and developed turbulent types of gas flow is independent of the presence or absence of the arc. This model of interaction between the electric arc and the turbulent gas flow is further refined on the basis of a comparison of the experimental findings with the calculations of other investigators. Figures 6; references 7: 6 Russian, 1 Western.
[411-1386]

INVESTIGATION OF THE STABILIZATION OF A PLASMA JET BY A GAS EDDY

DOBRINSKIY, E. K., URYUKOV, B. A. and FRIDBERG, A. E., Krasnoyarsk State
University

[Abstract] Efficient electric-arc heaters can be designed on the basis of
the stabilization of the electric arc in an eddy chamber in which the ratio
of peripheral velocity to mean flow rate $v_p/u = 100$. In this connection, ex-
perimental findings on the aerodynamic characteristics of such chambers and
on the processes of heat and mass transfer between the plasma jet and the
stabilizing gas eddy are presented. It is shown that, when in the stabilized
mode, the plasma jet lies within the confines of the zone of quasi-solid ro-
tation, which warrants regarding the stabilized mode as a result of the
laminarization of, at least, the external zone of the jet under the action
of the gas eddy. A simple kinematic model shows that the "laminarizing" ef-
fect of the gas eddy merely signifies the restriction of turbulence to the
flow core, since the pattern of heat and mass transfer in the flow core re-
mains turbulent even in the stabilized mode. Thus the term "laminarization
by the gas eddy" should be construed as the localization of the turbulent
axial region under the action of a centripetal mass force, or as the restric-
tion of the diffusion of turbulence into the external flow zones. The sta-
bility boundary is determined as a function of the relationship between Ri
and Re numbers, on the one hand, and the ratios of characteristic geometric
dimensions, on the other. The distribution of axial temperatures is mea-
sured and the "apparent" mass of the gas entering the plasma jet from the
stabilizing eddy is estimated. Figures 8; references 7 (Russian).
[411-1386]

ANALYSIS OF PLASMA JETS IN THE NEIGHBORHOOD OF THE ELECTRODES IN A COAXIAL
PLASMOTRON

DEGRAF, E. D., Alma-Ata Power Engineering Institute

[Abstract] A simple method of plasma analysis, termed the small monochro-
maticization method and based on the measurement of radiation within broad
spectral intervals (10-20 nm), is used here to analyze the plasma jets in
the neighborhood of the electrode in a coaxial plasmotron. With the aid of
this method, which reduces to the construction of a pyrometric curve for a
spectral sector of $\lambda_1 - \lambda_2$ width isolated with the aid of a standard set of
interference filters or conventional color filters, a 160-350 ampere air arc
moving under the action of a magnetic field in a $4.5 \cdot 10^{-2}$ m coaxial gap is
investigated and the presence of high-enthalpy sectors in the region of near-
electrode jets is thus demonstrated. At an arc current of 300-350 amperes
the temperature at the axis of the cathode jet is $16 \cdot 10^3$ K, and at the axis
of the anode jet, more than $20 \cdot 10^3$ K, while the electron concentration n_i =
10^{17} and higher. The temperature findings are in agreement with the Saha
equation, which is yet another proof of the suitability of the small mono-
chromaticization method which makes it possible to derive on the basis of a
single photograph the temperature distribution (or the electron density
field) in the cathodic and anodic jets as well as in the arc column. Figures
5; references 15: 14 Russian, 1 Western.
[400-1386]

AERODYNAMIC LOSSES IN BLADE ROWS OF THE DRIVE WHEELS OF TURBINES WITH UN-
STABLE FLOW AROUND THE BLADES

KOPELEV, S. Z., Doctor of Technical Sciences and ZIKEYEV, V. V., Engineer

[Abstract] A review is presented of methods used to determine aerodynamic
losses in the drive wheels of turbines. The most reliable method is experi-
mental study, either of a model or of an actual turbine stage. Studies have
been performed both on special test stands and in actual operating turbines.
A mathematical analysis is presented of the qualitative variation of rela-
tive loss increment as a function of relative spacing of blade rows, based
on the results of studies of blade rows with flow barriers installed before
them and shifted along the leading edge of the blade row. The relative loss

increment is directly proportional to the relative spacing of blades in the row and to the value of F_0, which depends on the condition of the boundary layer on the drive blades as the air stream flows around them, and also on the nonuniformity of the field of velocities. Based on data from the literature and special test studies performed on an actual turbine stage on a special test stand, equations are derived which allow the variation in efficiency of the turbine stage with changes in the closed axial gap to be calculated. These equations can determine the aerodynamic losses in blade rows under periodically unsteady flow conditions from test data produced with steady flows, and can also determine the change in efficiency of a stage as a function of changes in the profile of the stationary blades, their cooling system and the level of nonuniformity of the flow at the intake to the drive wheel. Figures 5; references 18: 17 Russian, 1 Western.
[388-6508]

RELATIONSHIP OF VIBRATIONS OF TUBULAR POWERPLANT ELEMENTS TO THE DYNAMIC CHARACTERISTICS OF A TWO-PHASE MOVING STREAM

FAKIN, B. S., candidate of technical sciences and GOL'DBERG, YE. N., engineer, Central Boiler and Turbine Institute

[Abstract] The reliability and durability of modern heat exchange equipment depend to a great extent on the vibration stability of the elements of this equipment. The movement of the two-phase heat-transfer media most commonly used in power engineering is accompanied by low-frequency pulsations in discharge, velocity, density, shear stresses, pressure and pressure differentials. The problem of determination of the parameters of vibration of structural elements in contact with two-phase media requires application of a combination of the theory of vibrations of solid bodies, the theory of random processes and the hydrodynamics of two-phase streams. This problem is studied as applicable to the longitudinal flow of an adiabatic two-phase stream around a cylindrical tube or rod. Experimental and calculated data on the vibration of a cylindrical element in a two-phase stream are compared, indicating satisfactory agreement for two different rod lengths. Figures 4; references 14: 10 Russian, 4 Western.
[367-6508]

A NONEQUILIBRIUM VISCOUS SHOCK LAYER IN THE VICINITY OF A CRITICAL POINT,
CONSIDERING ACCOMPANYING HEAT EXCHANGE

ZINCHENKO, V. I. and PYRKH, S. I., Tomsk

[Abstract] An analytic study is presented of a viscous shock layer in the
vicinity of the critical point on a spherically blunted body considering
heat exchange and chemical processes. It is assumed that the processes in
the gas phase are quasi-steady. The study shows the importance of a com-
bined approach to determination of the characteristics of flight of bodies
on assigned trajectories. Figures 5; references 14: 13 Russian, 1 Western.
[312-6508]

THE ASYMPTOTIC THEORY OF FLOW OF A SONIC STREAM AROUND A PROFILE

BREZHNEV, A. L. and CHERNOV, I. A., Saratov

[Abstract] A study is made of vortex-free flow of an ideal gas in the trans-
sonic area of velocities. Flows in which the field of velocities is analy-
tic at the limiting characteristic, which is the boundary of the transsonic
zone, are called natural or E flows. This study is limited at first to E
flows symmetrical relative to one axis. Non-self-similar solutions of the
Tricomi equation are presented, series with respect to self-similar compo-
nents describing symmetrical E flows without limiting lines in the trans-
sonic zone. Figures 3; references 13: 9 Russian, 3 Western.
[312-6508]

STRUCTURE OF THE WAKE AS A RAREFIED PLASMA FLOWS AROUND A RAPIDLY MOVING
BODY

ANISIMOV, S. I., MEDVEDEV, YU. V. and PITAYEVSKIY, L. P., Moscow

[Abstract] A study is made of the steady flow of a plasma in the vicinity
of a flat plate. The velocity of the plasma far from the plate is perpendicu-
lar to it. Both plasmas with identical and with different temperatures of
electrons and ions are studied. A comparison of the results of calculation
with the self-similar solution shows that the latter yields a practically
exact quantitative description of the flow at distances from the body such
that the interaction of the streams approaching from opposite sides of the
wake does not play a significant role. Figures 9; references 11: 9 Russian,
2 Western.
[312-6508]

THE INFLUENCE OF A MECHANICAL TURBULIZOR ON HEAT EXCHANGE BETWEEN A JET AND
A BARRIER AT THE CRITICAL POINT

ARALOV, A. D., engineer, YUDAYEV, B. N., dr of technical sciences prof

[Abstract] The effect of turbulence produced by a mechanical turbulator on
heat exchange between a jet from a nozzle and a planar barrier placed at
various distances away from it was studied. The ratio of the distance be-
tween the nozzle and the barrier and the nozzle diameter varied from 2 to
16. The speed of the flow from the nozzle was Re = 10^4-10^5. Heat transfer
was measured by a heat flux density sensor. Hydrodynamic measurements on
the jet made it possible to calculate the amount of heat transferred at the
critical point in a form which took account of turbulence of the incident
flow. Graphs of the results indicate that as the Strouhal number is in-
creased the speed on the axis of the jet is slowed more as the degree of
turbulence at the mouth of the nozzle rises. When the barrier was placed
in the principal section of the jet, the intensity of heat transfer at the
critical point decreased as the Strouhal number increased as a result of

reorganization of the flow structure. It is concluded that use of the
mechanical turbulizor makes it possible to control processes of turbulent
exchange in jets as well as heat transfer processes in which a jet inter-
acts with a barrier. Figures 3; references 6: 3 Russian, 3 Western.

INTERACTION OF AN AXIALLY SYMMETRICAL JET WITH A PLANAR BARRIER

STEPANOV, S. I., graduate student

[Abstract] The impingement of an axially symmetrical jet on a perpendicular
barrier was studied for Reynolds numbers from 26,500 to 48,200 and distances
of 2 to 10 times the nozzle diameter of 20 mm. The purpose was to compare
the experimental average rate curves and the distribution of frictional
stress on the surface with the calculated values obtained from numerical
solution of the Napier-Stokes equations.

Flow speeds were measured with heat-loss anemometers. The distance from the
surface of the barrier to the nondisturbed jet was on the order of 1.1-1.5
d_0 when the value of h/d_0 (ratio of distance to nozzle diameter) was in-
creased from 2 to 10. The experimental data were used to refine the boundary
conditions in calculating the area in which the jet interacted with the bar-
rier. The results obtained from a computer solution of the Navier-Stokes
equations were in good agreement with the observed values. Figures 3; ref-
erences 6: 2 Russian, 4 Western.

RADIATION OF AN ACOUSTIC PRESSURE WAVE BY A LINEAR EXPLOSION SOURCE INTO AN INFINITE MEDIUM

PODSTRYHACH, YA. S., Academician Ukrainian Academy of Sciences, PIDDUBNYAK, O. P. and TYKHONENKO, V. V., L'vov Branch of Mathematical Physics, Ukrainian Academy of Science Institute of Geophysics and Institute of Mathematics

[Abstract] Explosion of a linear charge of uniform density which is detonated instantaneously and with finite velocity into an infinite medium is investigated. Given that the charges can concentrate their energies in the required direction, the problem is solved in a linear approximation. At time greater than 0, the medium receives a pulsed perturbation uniformly distributed along the Z axis (cartesian system of coordinates) through a section H in length. This case occurs when a linear charge is instantaneously detonated. If the perturbation is uniformly distributed along the Z axis with respect to the section H in length, it moves at velocity V along this axis. This case corresponds to actual detonation of a charge initiated from one end. The solution permits analysis of the pressure field distribution in an acoustic medium around a linear charge. Figures 3; references 4 (Russian).
[269-8617]

USE OF A HOLOGRAPHIC COHEROMETER TO INVESTIGATE THE SPATIAL COHERENCE OF
RUBY-LASER RADIATION

[Abstract] The design of a holographic coherometer serving to record the
spatial coherence functions (SCF) of radiation is described, and the re-
sults of SCF measurements of ruby-laser radiation performed with the aid
of that device are presented. The optical diagram of the holographic co-
herometer includes mirrors, shaping lens, and reference beams. The image
of the investigated laser is projected by means of a telescope onto the
inlet plane of the coherometer and transmitted by means of lenses to the
hologram plane. The Fourier holograms thus obtained are such that the posi-
tion of the plane of the reconstructed image is independent of the wavelength
of the radiation, which is important to research into the radiation coherence
of sources in various regions of the spectrum. Measurements of the SCF of
the radiation of a ruby laser, performed with the aid of this device, served
to compare the SCF at operation of the laser in two modes: free lasing and
Q-switching, as well as to investigate the SCF of the laser radiation passed
through amplification stages. The degree of spatial coherence of the radia-
tion reached 0.45-0.5 in single-pulse mode and 0.18-0.22 in free lasing mode,
apparently owing to the marked difference in the developmental kinetics of
these modes. For the laser radiation passed through amplifier stages the
SCF tended to somewhat decrease, which may be due to the change in thermoop-
tical distortions in the ruby rod in the course of a single pulse. Figures
2; references 5 (Russian).
[395-1386]

A BASE MIRROR FOR THE ADJUSTMENT OF OPTICAL INSTRUMENTS

PRIKHOD'KO, V. N.

[Abstract] The plane mirrors usually used to adjust and check optical in-
struments have a shortcoming: to enhance precision and eliminate secondary
flashes, the specular coating is applied to the outer surface of the mirror
and cannot be protected against fog, dust and other deposits which adverse-
ly affect the reflection coefficient. Then also the specular coating is
liable to be contaminated by wetness, and its mechanical cleaning causes
the formation of tiny cracks. To solve this problem, the authors designed
a protective base glass in a steel frame attached to the plane mirror and
provided with a silicagel-containing drying attachment. The base glass is
tilted 2-5° in relation to the mirror so as to eliminate harmful flashes.
The assembling should be performed in special shops with hermetic sealing
of the joints between the components. The use of such protected mirrors
has already saved 5,000 rubles. Figure 1.
[395-1386]

A DISTURBED TOTAL REFLECTION REFRACTOMETER FOR MEASUREMENT OF THE OPTICAL
CONSTANTS OF ABSORBING MEDIA

MOLOCHNIKOV, B. I., LEYKIN, M. V., VASIL'YEVA, I. S., SHAKARYAN, E. S.,
ZOLOTAREV, V. M., MOROZOV, V. N., ISKHAKOV, B. O., ANIKIN, N. A. and
YEVDOKIMOVA, S. B.

[Abstract] The disturbed total reflection method (DTR) is a more accurate
method of measuring the optical constants of absorbing media compared with
the traditional light-shadow-boundary and photometric methods. Then measure-
ments of reflection coefficients for two angles of incidence differing by

$\sim 1°$ from one another can be performed with minimum error. The DTR refractom-
eter used for this purpose should satisfy the following requirements; the
angle of incidence of light on the DTR measuring element should vary with-
in 50-70° for the selection of the optimal angle of every particular rela-
tive refractive index; the beams of light incident on the DTR element
should be satisfactorily collimated (< 1'); and a sufficiently exact 10-20''
exposure of the angle of incidence should be assured. In addition, the mea-
surement of n and χ of liquid media in flow and the procurement of findings
on real time scale require assuring the simultaneous measurement of R for
two angles of incidence. A block diagram of a refractometer allowing for
these requirements is presented and described. The refractometer is de-
signed on the basis of a GS-5 goniometer. Tests of the specially designed
refractometer model showed that its ΔR error does not exceed 0.5% and the
stability of reading is no worse than 0.1-0.2% per hour. Figures 2; ref-
erences 6 (Russian).
[395-1386]

SYNTHESIS OF PLANE MIRROR SYSTEMS WITH THE AID OF BIQUATERNIONS

GREYM, I. A. and SHEFTEL', M. V.

[Abstract] The complex number-quarternion method, as previously developed
by the authors for calculation of mirror systems (MS) consisting of 2, 3,
and 4 mirrors, based on calculating the MS action operator in canonical
form, can be readily used to determine how the MS transforms space and
does not require conversion of findings from one coordinate system to an-
other. Now this method is used to find the position of the MS for both
parallel and converging runs of rays as a function of specified positions
of object and image. Sets of three orthogonal vectors each are used to
represent object and image, except that for the converging run of rays the
position of the origin of both vector sets is considered to be fixed in
space. Each point in space with the radius-vector $\vec{r}$ corresponds to the
biquaternion $R = 1 + \omega \vec{r}$, where ω is the Clifford symbol with a zero square,

$\omega^2 = 0$, and the origin 0 of the coordinate system corresponds to the biquaternion $R_0 = 1$. A corresponding system of equations is derived. References 3 (Russian).
[395-1386]

CONVERSION OF THE VECTORS OF AN OPTICAL SYSTEM CONSISTING OF FOUR PLANE MIRRORS

SIVTSOV, G. P.

[Abstract] Formulas for determing the position of the mirrors of a system of four plane mirrors according to two sets of three vectors each in the space of images and objects are presented. Since the system has an even number of mirrors, both three-vector sets have the same orientation, i.e., both are either right or left. The corresponding system of matrix equations is derived. A solution is presented for the case in which the planes of the first and second mirrors are parallel. By way of an example, calculations of a mirror system for a projector converting a vectored object to a vectored image are performed. The findings are in agreement with the theory. Reference 1 (Russian).
[395-1386]

EFFECT OF NON-PARALLEL NATURE OF RAYS IN A LIGHT BEAM AND OF POLARIZATION
OF RADIATION ON THE REFLECTION COEFFICIENT OF SOLIDS

BILENKO, D. I., DVORKIN, B. A., MEL'NIKOVA, T. YE., PYLAYEV, S. YE. and
SHEKHTER, Z. V.

[Abstract] The tightening of requirements for photometric accuracy of in-
struments used in research into, e.g., the optical properties of solids ac-
cording to the reflection spectrum, enhances the importance of the correct-
ness of measuring conditions. In the designing of devices for measurement
of the reflection coefficient on the basis of spectrophotometers there arise
difficulties associated with the low density of radiation energy, particu-
larly in the longwave IR region. Focusing the source's radiation on the
specimen causes an increase in the aperture of the ray and this, in itself
as well as owing to the effect of the polarization of radiation, causes
errors in interpreting the magnitude of the reflection coefficient. In
this connection a formula for the maximum permissible deviation of the mea-
sured reflection coefficient in relation to the aperture angle is presented.
It is shown that the polarizing effect of the optical system can be de-
scribed with the aid of a generalized Mueller M matrix for a non-ideal po-
larizer. A table of possible situations and corresponding formulas for
the reflection coefficient is presented. Measurements of the reflection
coefficient of standard specimens of Ge and Si singlecrystals with the aid
of a specially designed spectrophotometer attachment shaping a pyramidal
radiation beam with corresponding angular apertures of 12 and 34° and with
a 16° angle of incidence of the central ray were found to be in agreement
with the theory. Figures 3; references 5 (Russian).
[395-1386]

USSR   UDC 621.384.32

ESTIMATION OF THE EFFECT OF DESTABILIZING FACTORS ON SIGNAL DETECTION
CHARACTERISTICS

SHEMSHEDINOV, R. B. and DUNAYEV, A. S.

[Abstract] Approximate analytic formulas serving to simultaneously take
into account the effect of fluctuations in the noise power, signal, and
triggering threshold on the characteristics of signal detection with re-
spect to signals propagating in a turbulent atmosphere are presented. The
use of in situ devices requires taking into account the effect of a number
of destabilizing factors on energy characteristics of the system. Such
factors, which affect signal detection, are the fluctuations in the power
of the input signal due to instability of performance of the transmitter,
turbulence and variation in the microphysical properties of atmospheric
aerosol, changes in the reflecting properties of the illuminated surfaces,
instability of the parameters of the receiving channels, etc. These formu-
las are derived for cases in which the statistics of noise is described by
a normal distribution and the statistics of the fluctuations in the inten-
sity of signals propagating in a turbulent atmosphere is described by a
logarithmically normal distribution, with allowance for instances of a
Gaussian pattern of signal amplitude distribution. The findings can be
useful in designing in situ devices for estimating the effect of destabil-
izing factors on the characteristics of signal detection. Figures 2; ref-
erences 12: 11 Russian, 1 Western.
[395-1386]

EFFECT OF ECCENTRICITY AND END WOBBLE OF SCREENS ON THE PATTERN OF VARIA-
TION IN THE OUTPUT SIGNALS OF VERNIER SINE-COSINE ANGLE-DATA TRANSMITTERS

KHAYNATSKIY, O. A.

[Abstract] Photoelectric sine-cosine angle-data transmitters (SCADT) with
radial (flat) screens are widely used in metrology and automation engineer-
ing. Their accuracy largely depends on their graduation relative to their
geometrical axis and, in particular, on the eccentricity and end wobble of
the screens. In this connection, an equation serving to determine the com-
bined effect of the eccentricity and end wobble of the screen on the varia-
tion in the output signals of SCADT is derived. Formulas for the amplitude
modulation of useful SCADT signals and angular displacement of the nullpoints
of output signals, i.e., for the direct error of conversion, are presented.
In addition, formulas for precluding the angle error of SCADT due to eccen-
tricity and end wobble are given; in this connection, the tolerance for ec-
centricity should be selected as a function of the specified amplitude in-
stability of the output signals of SCADT in accordance with Eq. (19) or (20).
Figures 3; references 8 (Russian).
[395-1386]

DEPENDENCE OF INTEGRAL UV IRRADIATION ON THE SPECTRUM OF THE LUMINOUS FLUX
PRODUCED BY A SINGLE-LENS ILLUMINATION

KUZNETSOV, B. I.

[Abstract] Currently illuminators with a simplified optical system, based
on DKSR-3000 M lamps and single-lens condensers assuring increased radiant
energy density, are often used to simulate the effect of solar electromag-
netic radiation on materials in laboratory conditions. Experience shows

that the spectral composition of the luminous flux in the UV region pro-
duced by such illuminators does not remain stable upon prolonged operation
of the lamp. The integral luminous flux density in the entire (0.2-0.4 μm)
UV region is measured with the aid of F-7 photocells. Since the investiga-
tion of the resistance of materials to UV irradiation usually takes ten
hours and longer, this raises the question of whether the integral density
of the UV flux remains unchanged upon correction of irradiation in accord-
ance with F-7 measurements, and to what extent? This question was experi-
mentally elucidated in a laboratory setup designed to study changes in the
reflectivity of solids in a vacuum. It was found that errors of more than
20% then arise owing to the variation in the spectral composition of the
flux due to both the movement of the condensing lens along the optical axis
of the illuminator and the aging of the lamp. On the other hand, the experi-
ments also showed that the use of a chromatic condenser serves to focus on
the irradiated specimen the energy of a relatively narrow spectral interval
(150-200 nm), which is definitely a positive factor in laboratory research
into the effect of UV radiation on the physical properties of solids. Fig-
ures 4; references 4 (Russian).
[411-1386]

DEVELOPMENT AND APPLICATIONS OF HIGH-DENSITY LIGHT CONDUCTORS

DVERNYAKOV, V. S., PASICHNYY, V. V., KASICH-PILIPENKO, I. YE., YEREMINA,
T. V., SATTAROV, D. K., MURAV'YEVA, M. I. and GALANT, I. YE., Kiev Order
of Labor Red Banner Institute of Problems of Materials

[Abstract] Light conductors can be utilized for the concentration of radi-
ant solar energy for heating purposes. In this connection, considering
that a paraboloid mirror with an angular aperture of 120° is used as the
principal focusing element in solar power engineering, a light conductor
placed in the focal plane of the paraboloid must have an aperture of at
least 0.86 if it is to receive radiant flux converging at the angle of 120°.
This requires pairs of glasses with markedly different refractive indexes,

low absorption factors, and adequate resistance to intense radiant fluxes (1000-1500 watt/cm^2). Hence tests of different optical materials were conducted for this purpose. The most suitable proved to be the TK1, TK3, and TK23 heavy crown-glass varieties. These glasses have a relatively high refractice index (1.56-1.58) and hence light-conductor fiber strands can be used for this purpose. Of the glasses tested the pair TK23-157$_0$ was selected, and both rigid and flexible fiber light conductors were prepared from them and found to perform reliably in the focal spot of a 1.5 m diameter paraboloid mirror for several hours, thus demonstrating the possibility of developing high-density light conductors for the transmission of concentrated solar radiation from the focal zone of a solar concentrator to the site of its utilization. Figure 1; references 6: 5 Russian, 1 Western. [411-1386]

BREAKUP OF LARGE AND SMALL DROPS OF WATER BY SINGLE RUBY LASER PULSES

NOVIKOV, V. I. and POZHIDAYEV, V. N., Moscow

[Abstract] Experiments involving the breakup of drops of water by single ruby laser pulses are described. The large drops were about 2 mm in diameter, suspended on the end of a capillary tube. The small drops were in the micron range of diameters. A series of photographs of the process of breakup of a drop is presented, showing that the drop swells and emits streams of water before it explodes into fragments. Photographs of individual fragments at various intervals after irradiation are also presented. The results of the experiments indicate that the effect of breakup of a large water drop by a single ruby laser pulse results from the high intensity of the light field in the pulse, not from thermal effects. The tiny drops studied were generated by an ultrasonic sprayer. It is estimated by indirect methods that the characteristic time of breakup of the 4-6 µm droplets is about 20 ns. Figures 8; references 5 (Russian). [312-6508]

THRESHOLD AMPLIFICATION AND FREQUENCIES OF A NEAR-CONFOCAL OPTICAL RING
RESONATOR WITH A SPATIALLY HETEROGENEOUS MEDIUM

BOYTSOV, V. F.

[Abstract] A study is made of an optical ring resonator with two flat
mirrors and one spherical mirror, assumed large enough to ignore diffrac-
tion. Design equations for the resonator are presented, taken from an
earlier work, and briefly analyzed. It is noted that the use of capillary
tubes in ring lasers, with diameters comparable to the transverse dimen-
sions of the field of the resonator, leads to the need for the construc-
tion of optical resonator models of increasing complexity. The one ana-
lyzed in this article is useful for explanation of the frequency indepen-
dence of counter waves in ring lasers. References 3: 2 Russian, 1 Western.
[389-6508]

INTERACTION OF MODES AND FLUCTUATIONS OF RADIATION IN A MULTIMODE LASER

KRIVOSHCHEKOV, G. V. and SMIRNOV, V. S.

[Abstract] This article is written to call attention to a fact usually
ignored in analysis of multimode lasing. This factor is the influence of
the phase interaction of fluctuating modes on the stability of lasing and
the mode composition of the radiation. For greater clarity, the analysis
is restricted to a solid state laser with a homogeneously expanded amplifi-
cation line and a Fabry-Perot resonator. No attempt is made to find any
mechanism of dynamic instability of multimode lasing. The purpose of the
work is strictly to call attention to the significance of random forces
which may appear after sufficiently long operating times. References 9:
8 Russian, 1 Western.
[389-6508]

USSR   UDC   621.373:535

THE OPERATION OF A WAVEGUIDE OPTICAL AMPLIFIER

BORISOVA, M. S., KORYAKOVSKIY, A. S. and SVIRIDOV, M. V.

[Abstract]   Results are presented from an experimental study of a neon-
helium waveguide optical amplifier operating at λ = 3.39 µm and excited by
direct current. Particular attention is given to its spontaneous radiation,
which determines the threshold sensitivity of photorecording devices with
preliminary optical amplification. The cuvette of the optical amplifier is
a three-dimensional filter and the use of the optical amplifier as a pream-
plifier allows the noises caused by spontaneous radiation of the active medi-
um to be significantly reduced. Figures 3; references 7: 3 Russian, 4
Western.
[389-6508]

USSR   UDC   621.373:535

STABILITY OF THE STATE OF POLARIZATION OF RADIATION BY A SINGLE-MODE GAS
LASER WITH SLIGHTLY ANISOTROPIC RESONATOR

BORISOVA, M. S. and MAZAN'KO, I. P.

[Abstract] A theory is presented to explain the stability of the state of
polarization of gas laser radiation with a slightly anisotropic resonator
with homogeneous and heterogeneous spreading of the spectral line of ampli-
fication, considering the fact that the resonator might not be tuned to the
center. It is found that the reaction of polarization of the laser radia-
tion in response to perturbations depends in this case on the lasing fre-
quency and is distinguished by a variety of reactions. It is particularly
noted that in a laser resonator with phase anisotropy with a certain mis-
alignment, the polarization state loses stability. This is reflected in

the spectra of natural fluctuations of the direction and elipticity of polarization of the laser radiation. Figure 1; references 12: 7 Russian, 5 Western.
[389-6508]

THE METHOD OF REABSORPTION AT HIGH OPTICAL DENSITIES IN THE CASE OF TWO IDENTICAL TUBES

SMIRNOV, V. V. and TSYGIR, O. D.

[Abstract] The function $\Phi(\chi_0 \ell, a)$ was calculated for high optical densities. The function is found to be nonmonotonic where a is between 0 and $\sqrt{1.5}$. This has not been reported previously in the literature. Figures 2; references 3 (Russian).
[390-6508]

SOME DETAILS OF THE SPECTRUM OF SATURATED ABSORPTION OF THE RADIATION OF THE CO_2 LASER BY A MOLECULE OF SiF_4

IVANOV, E. I. and KRYLOV, I. R.

[Abstract] The phenomenon of saturation of absorption of a weak monochromatic wave by a strong counterwave of the same frequency is the basis for one method of high-resolution laser spectroscopy. The method has facilitated progress in molecular spectroscopy in the area of the study of vibrational-rotational bands of certain molecules. An earlier work has studied the possibility of using the absorption lines of the SiF_4 molecule to stabilize CO_2

lasers at 9.4 μm. This work presents some additional detail on the spectrum
of saturated absorption of the SiF_4 molecule. Figures illustrate the entire
spectrum of saturated absorption and fragments at the P(30) and P(34) bands
of carbon dioxide. Figures 2; references 6: 2 Russian, 4 Western.
[390-6508]

STUDY OF THE IONIC COMPOSITION OF A PULSE DISCHARGE PLASMA IN NEON AND ARGON
IN THIN TUBES

YEGOROV, V. S., PASTOR, A. A. and FARES, M. E.

[Abstract] A study is made of the ionic composition of pulse discharge plas-
mas in neon and argon. The current pulse in the gas was produced by a peri-
odic discharge of a capacitor through a glass tube 3 mm in diameter and 20-
25 cm long, containing gas with a pressure of 1 to 10 mm Hg. The concentra-
tions of charged particles, electron gas temperature and concentration of
metastable atoms were measured under the same discharge conditions under
which the mass-spectrometric measurements were performed. The calculations
performed indicate that there is satisfactory agreement between the flux of
charged particles to the wall of the discharge tube and the flux "upward"
from metastable states at gas pressures of about 5 mm Hg. Figures 3; ref-
erences 13: 8 Russian, 5 Western.
[390-6508]

USE OF LONGWAVE INFRARED SPECTROSCOPY TO STUDY INTERMOLECULAR INTERACTIONS
IN A CONDENSED MEDIUM

LIBOV, V. S. and PEROVA, T. S.

[Abstract] A discussion is presented of works from the literature on prob-
lems related to the appearance of various types of intermolecular forces in
longwave IR spectra, resulting from collective movement of molecules in con-
densed media. The purpose of the work is to summarize existing concepts on
the nature of long infrared absorption spectra of condensed media (liquids
and solids) and to note means of their use for the study of various physi-
cal and chemical properties of matter and the processes which occur within
matter. The latest concepts of the nature of formation of long infrared ab-
sorption spectra of condensed media are outlined, and manifestations of in-
termolecular interactions in long infrared spectra of various condensed sys-
tems are discussed. Figure 1; references 115: 30 Russian, 85 Western.
[427-6508]

USE OF AFOCAL COMPENSATORS IN LENS ELEMENTS

POLSHKIN, V. KH.

[Abstract] An example is presented of the use of two afocal compensators
in a lens. All of the initial data necessary are determined for design of
each of the compensators. Use of the two compensators allows rapid design
of a lens with a focal length of 1200 mm and a relative aperture of f5.6.
The field of view is 20° and the image is practically of diffraction quality
over a broad range of the light spectrum, 546 to 830 mm. Figures 4; refer-
ence 1 (Russian).
[427-6508]

USSR   UDC 771.351.76

THE USE OF ASPHERICAL SURFACES IN LENSES WITH VARIABLE FOCAL LENGTH

SHPYAKIN, M. G.

[Abstract] Analysis of the aberrations in lenses with great zoom factors has shown that the high astigmatism which they manifest results primarily from higher orders of the meridional component of curvature of the image, exceeding the third order aberrations by several times. As an example, a study is made of the results of introduction of aspherical surfaces to the "Variogoir-T-6" television lens, a 15-150 mm zoom, to improve its field aberrations at short focal distances. Relatively slight aspherization both improves image quality and produces a wider-angle system. Figures 2; references 2 (Russian).
[427-6508]

USSR

OPTICAL SYSTEMS WITH BRIGHTNESS AMPLIFIERS

PETRASH, G. G., doctor of physical-mathematical sciences, senior scientific fellow, and KAZARYAN, M. A., candidate of physical and mathematical sciences, junior scientific fellow, Institute of Physics imeni P. N. Lebedev, Academy of Sciences USSR

[Abstract] The possibility of using the light amplification principle of the laser for optical systems with brightness amplification is discussed. It is noted that the pumping power required to produce a continuous device operating throughout the visible range of frequencies would be unrealistic, but if one is willing to make do with a limited range of light frequencies and pulsed operation, the use of a copper vapor laser to produce a projection microscope with brightness amplification is quite realistic. A device of this sort has been in operation at the authors' Institute since 1972,

and is capable of achieving magnifications of up to 18,000 X, with the image transmitted onto a screen 25 m^2 in area bright enough for observation in an undarkened room. The resolution of the system is close to the diffraction limit. Photographs of objects made from the screen are presented. References 2 (Russian).
[429-6508]

STABILITY OF MOTION OF A RIGID SHAFT ROTATING IN ROLLER BEARINGS

KEL'ZON, A. A., Leningrad Higher Marine Engineering School imeni S. O.
Makarov

[Abstract] The classical relation between deformation and radial force in
roller bearings is here generalized by considering a random displacement of
the shaft and its subsequent precession, at a frequency equal to the rota-
tional speed, about the bearing axis. Assuming an arbitrary fractional ex-
ponent in the Hertz equation and a balanced rigid shaft in roller bearings,
its kinetic and potential energies are calculated in terms of the Routh func-
tion. The stability of its motion, in a system with variable elasticity, is
then analyzed with the aid of Routh's theorem and Lyapunov's supplement. As
a result, the conditions of instability and the dependence of the rotor pres-
sure on the rotor speed are established, which for any given bearing (listed
in the catalog) yield its maximum permissible operating speed. The article
was presented by academician L. I. SEDOV on 15 Sep 78. Figures 1; references
10 (Russian).
[420-2415]

ONE METHOD OF SOLUTION OF THE PROBLEM OF STATICS OF REINFORCED SHELLS

SKVIRENKO, S. M., Tashkent Polytechnical Institute imeni Abu Raykhan Beruni

[Abstract] A calculation model of an orthogonal reinforced thin elastic
isotropic circular cylindrical shell is constructed on the basis of the
theory of shells. The supports are modeled as strips of the shell of vari-
able thickness. Within the framework of this model, derivatives are ob-
tained for a finite-difference analogue of the deformation energy functional
with respect to components of the displacements, allowing very effective

search for a solution by the method of conjugate gradients. The solution plan suggested can easily determine the stresses from values of displacements and can be extended to a broader class of thin-wall structures. Figures 2; references 6: 5 Russian, 1 Western.
[426-6508]

LONGITUDINAL WAVES IN A HOLLOW TRANSVERSELY ISOTROPIC CYLINDER WITH INITIAL STRESS

KUSHNIR, V. P., Kiev State University

[Abstract] This article is dedicated to a study of the longitudinal waves propagating in a long hollow compressible transversely isotropic cylinder with initial stresses applied along the axis. The study is based on three-dimensional linearized equations from the theory of elasticity within the framework of arbitrary (finite) initial deformations in a Lagrangian system of coordinates. As wall thickness of the cylinder decreases, frequencies appear at which the initial stresses do not influence the change in propagation velocity of P waves in hollow cylinders. These frequencies become lower as wall thickness decreases. For certain modes, the initial stresses are significant, 10 to 20% of the change of P wave propagation velocity at the critical frequency. The change in wave propagation velocity with initial stress is linear. Figures 6; references 9: 7 Russian, 2 Western.
[428-6508]

INFLUENCE OF A SPHERICAL CAVITY ON THE STRESS-STRAIN STATE OF AN ELASTIC
CYLINDER WHICH IS TWISTED

OSTASHEVSKAYA, N. YA., Ukrainian Scientific Research of Economics and the
Organization of Agriculture, Kiev

[Abstract] Numerical results are presented from the solution of the prob-
lem of twisting of an elastic cylinder of finite length with a spherical
cavity. In contrast to earlier works, the problem is formulated in dis-
placements. The maximum value of displacement is found at points in the
interval between 0.25 and 0.5 R and between 0.87 and 0.97 R, while stress
reaches its maximum at 1.0 R when displacement is 0.25 R. Cutting of the
infinite system of algebraic equations down to 8th order still provides suf-
ficient accuracy of the calculated results. Figures 3; references 4: 2
Russian, 2 Western.
[428-6508]

DEFORMATION OF A REGULARLY STRATIFIED HALFSPACE UNDER A VIBRATING LOAD

SHUL'GA, N. A. and YAMKOVOY, A. I., Institute of Mechanics, Ukrainian Acade-
my of Sciences, Kiev

[Abstract] Methods used in earlier works study the deformation of an iso-
tropic elastic halfspace formed by alternation of two layers with different
thicknesses, scale factors and densities, is extended to the general three-
dimensional case. The solution indicates that when the combination of
mechanical and geometric parameters of the zones of transmission agree,
the structures of the stress-strain state in the halfspace are periodic in

nature with respect to x_3: if the combinations of these parameters corres-
pond to nontransmitting zones of the structure, the stress-strain state in
the halfspace attenuates (acts as a surface effect). Figures 3; references
5 (Russian).
[428-6508]

NATURAL OSCILLATIONS OF AN ATTACHED MULTILAYER CYLINDRICAL SHELL

PROKOPENKO, N. YA., Institute of Mechanics, Ukrainian Academy of Sciences,
Kiev

[Abstract] A study is made of a thin, multilayer cylindrical shell of given
radius and length supported by longitudinal and circular ribs. The shell
has constant thickness and is made of an arbitrary number of orthotropic
layers. The ends of the shell are hinged and exposed to uniformly distri-
buted axial compressive stresses. The natural oscillating frequencies of
the shell are determined within the framework of the classical theory of
multilayer shells, based on the use of the hypothesis of underformed normals
for the entire packet. It is assumed that the main directions of elasticity
coincide with the directions of the coordinate lines, while the layers re-
main elastic during deformation and operate together without slipping. The
equations of the strength of materials are used for the reinforcing ribs;
eccentricity of the ribs relative to the middle surface of the shell is
not considered. The energy method is used to determine the frequency of
natural oscillations of the ribbed shell. Figures 5; references 6: 5 Rus-
sian, 1 Western.
[428-6508]

THE PROBLEM OF FREE OSCILLATIONS OF A RIBBED CYLINDRICAL SHELL WITH AN
ABSOLUTELY SOLID BODY

PALAMARCHUK, V. G., Institute of Mechanics, Ukrainian Academy of Sciences,
Kiev

[Abstract] A study is made of a closed circular cylindrical shell rein-
forced with stringers and ribs, to which is attached an absolutely rigid
body of given mass hinged at four points to the interior of the shell.
Since the rigidity of the shell in the tangential plane is much greater
than its rigidity in the radial direction, the inertial forces of the shell
in the tangential plane are ignored. A numerical example is appended, in-
dicating that as the distance between attachment points of the body increas-
es, the minimum natural oscillating frequency of the system decreases. Fig-
ures 2; references 5 (Russian).
[428-6508]

SOME INVERSE PROBLEMS FOR CYLINDRICAL SHELLS

RUBEZHANSKIY, YU. I., Institute of Mechanics, Ukrainian Academy of Sciences,
Kiev

[Abstract] A study is made of thin, circular, closed cylindrical shells
exposed to a normal load distributed symmetrically relative to the axis of
the cylinder. Two methods of attachment of the shell are studied: clamp-
ing and hinged attachment. The problems studied are determination of the
load at which the bending function of the shell is the best means for approxi-
mation of a certain assigned bending function, and determination of the load

at which the distribution of stresses in the shell is the best mean square approximation of a certain preassigned stress distribution. The Ritz method and a spline function are used to solve the problem of the stress-strain state of the shell. Figures 2; references 8: 7 Russian, 1 Western.
[428-6508]

STUDY OF HETEROGENEOUS NONLINEAR PROBLEMS OF THE THEORY OF RIBBED SHELLS

GAVRILENKO, G. D., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] A study is made of a thinwall cylindrical shell reinforced with ribs and stringers, with eccentricity relative to the midsurface of the shell. The shell is acted upon by an external load: any combination of axial compression and external pressure. The behavior of the shell is described with nonlinear differential equations, while the ribs are treated as one-dimensional elements. The flexure and bending of the ribs in the tangential plane is assumed to be negligible. Figures 3; references 8: 5 Russian, 3 Western.
[428-6508]

THE INFLUENCE OF HARDENING OF MATERIAL ON THE STRENGTH OF CYLINDRICAL SHELLS
IN AXIAL COMPRESSION

ANDREYEV, L. V., BOGATYR', G. P., DOTSENKO, V. P. and KHMELOVSKIY, L. T.,
Dnepropetrovsk State University

[Abstract] A study is made of the influence of hardening of material on
the axial compressive strength of circular shells. Experimental studies
were performed using smooth turned shells made of thick-wall pipe of an
aluminum-magnesium alloy (AMg6). Thirty six specimens were tested in all:
8 each of four different types of shells corresponding to four levels of
deformation in hardening, plus 4 specimens for construction of compression
diagrams. After deformation, the blanks were held in air for one year,
and the specimens were turned with radius-to-height ratios of 10, 25, 50
and 80. The test results indicated that the value of Young's modulus of
all specimens was $6.67 \cdot 10^{10}$ Pa, while the elastic limit and yield point de-
pend linearly on the preliminary deformation of the material. The studies
show that preliminary plastic deformation causes a significant increase in
the critical stress of loss of stability of elastic-plastic shells. Fig-
ures 3; references 25: 23 Russian, 2 Western.
[428-6508]

ON LONGITUDINAL VIBRATION OF AN ELASTIC CATERPILLAR TRACK

AVRAMOV, V. P., dr of technical sciences prof, KOKHANOVSKIY, N. V., engi-
neer, and OL'SHANSKIY, V. P., candidate of technical sciences

[Abstract] Two approaches to calculating longitudinal vibrations of a sec-
tion of elastic caterpillar track are possible: 1. as a system with pa-
rameters evenly distributed over its length; 2. as a system consisting of

N alternating masses each of which is equal to the mass of one link, connect-
ed by weightless elastic elements which in the general case have internal
losses. These two methods are compared, with internal hysteresis losses
ignored. The maximum value for the natural frequency of longitudinal vi-
brations of a sector is calculated. In studying induced vibrations result-
ing from periodic action, the theory of the elastic band can lead to major
errors in calculating dynamic forces. Figures 1; references 2 (Russian).

CALCULATIONS FOR A THIN TAB

SERGEYEV, V. V., candidate of technical sciences, CHEPRASOV, D. P., candi-
date of technical sciences docent, and BYKOV, V. A., engineer

[Abstract] The stress-strain state of a thin tab containing a circular hole
for a pin is considered. The circular pin is initially in contact with the
inner surface of the tab at one point, and further displacement of the pin
results in deformation of the tab, increasing its curvature and producing
an area of the pin which is in continuous contact with the deformed surface
of the tab. The mathematical approach starts with analysis of this change
in curvature of the tab. The angular, radial and circumferential displace-
ment of the section of the tab in contact with the pin are calculated in
terms of the initial values and the angle subtended by the contacting re-
gion. Graphs of these parameters and the crosscutting and normal forces
and the bending moment operating on the section are presented. Figures 3;
references 6 (Russian).

ON THE SYMMETRY PROPERTIES OF THE STABILITY EQUATIONS FOR SHELLS OF REVOLUTION

POPOV, B. G., candidate of technical sciences

[Abstract] For shells of revolution under axially symmetrical subcritical stress, a variation method is used to obtain the stability equations. The original stress state of the shell is considered to be governed by solution of the static problem in linear form, with the initial displacements set at zero. The controlling system of first-order differential equations is obtained by a matrix method which has been used previously for problems of the statics of a shell. The solutions sought are expanded in Fourier series of the angular coordinate defining the position of the meridian. The symmetry characteristics derived are found to be the same as those for the governing equations in statics problems. References 5 (Russian).

EXPERIMENTAL STUDY OF THE STRESS-STRAIN STATE OF SPHERICAL SANDWICH SHELLS

KOBELEV, V. N., dr of technical sciences, professor, KOTEL'NIKOV, V. YU., candidate of technical sciences, and POLTKO, V. G., engineer

[Abstract] Because of the difficulty of making theoretical stress-strain calculations for three-layered spherical shells with outer walls of variable thickness, experimental studies were made. Eight hemispherical models of aluminum alloy with foamed epoxy filler, and with a variation of the outside wall thickness from 0.6 mm at the flanged edge to 1.0 mm at the top of the dome were used. The experimental apparatus contained a hemispherical depression with a number of separate "elastic chambers," into which compressed

gas could be introduced to produce uniformly or nonuniformly distributed
loads. Deformation was measured by means of strain gages. A table of ex-
perimental values and graphs of certain parameters are presented. Particu-
larly large deformations were detected in the edge area. The bearing layer
on the external side under pressure was in a more intensely stressed state
than the inner wall. The experimental results will be of use in testing
theoretical calculation methods. Figures 3; references 2 (Russian).

EQUATIONS FOR THIN SHELLS IN THE CASE OF STRONGLY INHOMOGENEOUS STRESSED
AND DEFORMED STATES

KABANOV, V. V., Novosibirsk

[Abstract] The case of a thin elastic shell, the central surface of which
is referenced to lines of curvature, is analyzed and general nonlinear
equations are derived for the deformation of this surface. The only assump-
tion is that the deformations are small as compared to unity. The equations
apply to a deformed and nondeformed metric for the cases of loads which are
directionally constant and those which follow the surface. The resulting
cumbersome equations are simplified by eliminating nonlinear terms from the
expressions for the deformations which contain shear deformation factors
and dropping nonlinear terms with factors containing angles of rotation of
the elements of the central surface with respect to the normal. In thin
shells, these angles considerably less than the angles of rotation of the
normal. Stability equations are also derived which are suitable for the
study of general and local forms of stability loss, as well as in the case
of great variability of the original stressed and deformed state of the
shell. In the case of moderately large angles of rotation, these equations
are not much more complex than equations derived from the theory for gently
sloping shells. Figures 2; references 7 (Russian).
[8225-398]

THE FORMULATION OF THE SOLUTIONS OF THE EQUATIONS FOR THE FREE OSCILLATIONS
OF A CYLINDRICAL SHELL WITH A VARIABLE THICKNESS ALONG THE GENERATRIX

BERGMAN, R. M., SIDORIN, S A. and TOVSTIK, P. YE., Baku, Leningrad

[Abstract] A cylindrical shell which is supported in a hinged manner has
a radius of curvature and thickness which are variable along the generatrix.
A system of differential, moment equations is written for the free oscilla-
tions of the shell, and then solved by asymptotic integration. It is found
in formulating the first approximation of the integrals of the quasitangen-
tial oscillations of the shell that it is necessary to take into account the
variation in the thickness at the outset. The oscillatory cases considered
include those where the variability of the stressed and deformed states are
high, as well as low, a case where the frequency equation does not depend
on the boundary conditions and that where a point of inflection is present
in the integration segment. An approximate expression is also found for
the lowest oscillation frequencies with specific assumptions concerning
shell geometry. The limitations of the various analytical expressions are
discussed quantitatively. Figures 1; references 5 (Russian).
[8225-398]

NONLINEAR PARAMETRIC OSCILLATIONS OF A CYLINDRICAL TANK CONTAINING A LIQUID

OBRAZTSOVA, YE. I. and SHKLYARCHUK, F. N., Moscow

[Abstract] A thin-walled cylindrical tank with a flexible bottom having
the form of an arbitrary shell of revolution is partly filled with an ideal
compressible fluid. The cylindrical shell is loaded at the bottom and top
end faces with longitudinal reactions from the support, which executes longi-
tudinal oscillations along with the tank. It is assumed that the upper and

lower support frames are absolutely rigid and the cylindrical shell is hinged to them. In the case of dynamic instability of the tank shell, with axially symmetric oscillations, a nonaxially symmetric form of the oscillations appears, the amplitude of which rises rapidly and then goes into a limited cycle mode because of system nonlinearity. The major part is played in this case by the geometric nonlinearity of the thin shell, which is manifest at amplitudes of the normal displacements with respect to the nonaxially symmetric form on the order of the thickness of the shell. For a fluid, such displacements are small and the hydrodynamic problem can thus be treated in a linear formulation. It is further assumed that with dynamic instability of the tank, only one of the nonaxially symmetric forms of the oscillations of the cylindrical shell is excited. Equations are written and solved for the nonlinear oscillations of the tank and liquid, which are applicable to various problems related to the nonlinear interaction of the axially and nonaxially symmetric oscillations of the tank and liquid. The amplitudes of the nonlinear oscillations are determined at the primary parametric resonance. The specific example of a cylindrical tank with a hemispherical bottom, completely filled with an incompressible fluid is analyzed numerically. The boundary of the region of dynamic instability at the primary parametric resonance is plotted graphically from the derived expressions; the amplitude of the stable parametric oscillations of a nonaxially symmetric form, the amplitude of the astable parametric oscillations, and the amplitude--frequency response for free nonlinear oscillations of a nonaxially symmetric form are all shown graphically. The nonlinear component of the longitudinal force which is manifest in the case of dynamic instability of the shell considerably exceeds the linear component. Other numerical examples are adduced which show good agreement between the derived expressions and data found in the literature. Figures 4; references 12: 10 Russian, 2 Western.
[8225-398]

UDC   539.3

DYNAMIC TWISTING OF A CONICAL ROD

AMRAKHOV, A. N., Kirovabad

[Abstract] Dynamic torsion is applied to a conical rod of finite length, one end of which is secured. A partial differential equation is written and solved for the displacement as an arbitrary function of the angular coordinate and time. It is found that much as in the case of the dynamic twisting of cylindrical rods, with the propagation of torsional waves in conical rods, each spherical section of the cone will oscillate in accordance with the specified oscillation of the end section. In the general case, these oscillations consist of the superimposition of two forms: oscillations where the sections of the cone rotate about the axis as a whole, and an infinite number of oscillations, in which the sections of the cone are distorted, so that following the deformation, spherical ones remain. The stress fields corresponding to the first kind of waves produce the major perturbations; the torque due to the stresses corresponding to the second kind in any spherical section of the cone is equal to zero. The approach employed here can also be extended to the case of a hollow cone. References 10: 5 Russian, 5 Western.
[8225-398]

ON THE DISCRIMINATION OF THE MOTIONS IN THE PROBLEM OF STABILIZING BIPEDAL
WALKING

BOLOTIN, YU. V., Moscow

[Abstract] A direct approximation algorithm for the control of bipedal
travel is developed on the basis of the following formulation of the prob-
lem: the controlling moments of the motors are generated as functions of
measurements so as to provide for stable motion in any trajectory from a
specified family of trajectories. The cases analyzed include: stabiliza-
tion of bipedal walking and running on an inclined surface where the feet
strike the surface in an ideally inelastic manner; the gaits which are pos-
sible for the bipedal device, i.e., symmetrical gaits with the knees either
bent forward or backward, as well as skipping; and variations in the speed
of travel ranging from walking in place to an accelerating run. The pro-
posed algorithm is one for the free stabilization of the device in the
sense that walking stability is established independently of the maximum
value of the forward velocity, which can change with a change in the char-
acteristics of the support surface such as viscosity or pliability. The
shock absorbing effect with the feet striking the surface is the decisive
factor in assuring the stability of forward travel. The resulting struc-
ture of the possible gaits has a number of anthropomorphic features: the
existence of a natural travel speed for each configuration; a forward in-
clination and transition to skipping and then to running with an increase
in speed. Figures 2; references 4 (Russian).
[8225-398]

DYNAMIC PROCESSES IN A VANED GAS BEARING

BRAGIN, A. N., Moscow

[Abstract] A vaned gas bearing is a circular fitting from the sides of
which extend metal vanes which come in contact with a shaft. The pressure
in the areas behind the vanes serves to hold the shaft in position and cor-
rect imbalances and precession. Tests were made using a rotor weighing
0.835 kg and a shaft with a diameter of 30 mm; two bearings 30 mm long and
90 mm apart held the shaft. Speeds were up to 2400 Hz. Resonance peaks
were found between 100 and 400 Hz in startup regimes. Curves of the ampli-
tude of rotor vibrations as a function of disbalance are presented. Good
stability was obtained between 50 and 1500 Hz with a vibrational overload
up to 12 grams. As the gaps between the vanes were increased, damping de-
creased and the maximum resonance amplitude also rose, while smaller gaps
and higher resonance frequencies led to increased rigidity. It was found
that the elastic characteristics were close to linear, meaning that a line-
ar model can be used for approximating dynamic processes in these bearings.
Nonlinearities arose for large vibration loads. The frequency of rotation
of the rotor had only a small effect on the amplitude of the induced vibra-
tions in vibrational excitation. The bearings were found to be usable with
an eccentric disbalance up to 10 microns. The bearings are found promising
for use in high-speed rotor systems with static loads on the order of 0.1
kilogram per square centimeter. Figures 6; references 4 (Russian).

ON SHOCK ABSORPTION FOR THE ROTATING PARTS OF MECHANISMS

AKULENKO, L. D. and BOLOTNIK, N. N., Moscow

[Abstract] A mechanical system consisting of an unbalanced rotor which rotates about an axis which is rigidly coupled to a housing is analyzed. The rotor and housing are absolutely rigid; the housing is coupled to a stationary base by means of a viscous elastic shock absorber with a linear characteristic. A differential equation of motion is written for the rotor and solved with an asymptotic approximation for the case of small angular accelerations of the rotor rotation. The problem of optimal control of shock absorber stiffness is solved so as to assure a minimum of the amplitude peak of the housing oscillations during the acceleration of the rotor. The influence of the damping and stiffness factors of the shock absorber on the motion of the housing is analyzed and the amplitude-frequency response of the system is shown graphically as a function of the stiffness factor. Analytical expressions are derived for optimal system parameters as well as the reduction in the maximum amplitude of the oscillations. Figures 2; references 7: 4 Russian, 3 Western.
[8225-398]

RANDOM HEAT STRESSES IN AN ELASTIC SPACE WITH A CYLINDRICAL CAVITY

LENYUK, M. P. and BUKATAR, M. I., Chernovtsy State University

[Abstract] A uniform isotropic elastic space with cylindrical cavity of radius R with zero temperature throughout is studied. At t greater than 0, the temperature on the cavity surface $r = R$ is $Q(R,t) = T_0(t)$, where

$T_0(t)$ is a random time function. The cavity is considered to be free of radial stress. The random temperature field in an elastic space with cylindrical cavity is described by the function $T(r,t)$, which is a solution to the generalized equation of thermal conductivity. If the mathematical expectation is $M[T_0(t)] = 0$, then the temperature distribution equation will yield $M[T(r,t)] = 0$. A determinant solution of the problem is given and a correlation matrix is derived. References 5 (Russian).
[269-8617]

CONSTRUCTION OF STABILITY THEORY FOR THIN-WALLED CYLINDRICAL SHELLS UNDER EXTERNAL PRESSURE

HUZ', A. N., academician, Institute of Mechanics, Ukrainian Academy of Sciences

[Abstract] Construction of a linearized theory of elastic stability of thin-walled circular cylindrical shells under the influence of uniform external pressure in the form of a "tracking" load is considered. The relationship of the two-dimensional theory of shells constructed according to the Kirchhoff-Love hypothesis is used, where precritical deformations occur and the precritical state is defined by a geometrically linear theory. Basic system of equations with symmetric matrix of differential operators is derived. Only by refining the earlier theory can we derive a symmetric matrix of differential operators under the effect of external pressure in the form of a 'tracking" load. References 10: 9 Russian, 1 Western.
[284-8617]

USSR   UDC   539.3

STABILITY OF IMPERFECT CYLINDRICAL SHELLS

HAVRYLENKO, H. D., Institute of Mechanics, Ukrainian Academy of Sciences

[Abstract] Significant divergence between experimental critical values and
their theoretically computed levels is due to a number of factors, primary
of which is the non-uniform precritical state. This occurs particularly in
shells having initial imperfection of form. The presence of imperfections
must be computed when calculating shells. Existing methods assume: 1) the
precritical state is a uniform membrane state, or non-uniform but linear;
2) form of loss of stability coincides with form according to the precriti-
cal shape of the shell. The method of numerical calculation of stability
of imperfect cylindrical shells permits us to tackle problems of stability
in linear and non-linear formulation, to trace the effect of axisymmetric
and non-axisymmetric spans on the critical loads and effect of momentum of
the precritical state on upper critical loads, and to evaluate the effect
of non-uniformity of the precritical state on N_{cr}, to consider the non-axi-
symmetric type of load. References 3: 2 Russian, 1 Western.
[284-8617]

USSR   UDC   539.3:534.1

OSCILLATIONS OF MULTIPLY CONNECTED THICK PLATES IN THE NON-CLASSICAL STATE-
MENT

KOSMODAMIANS'KYY, O. S. and STOROZHEV, V. I., Donetsk State University

[Abstract] A basic system of uniform solutions of the three-dimensional
problem of stationary oscillations of plates using the model of an elastic
Kosser medium with constrained rotation was previously constructed. Now
the constraint establishing the interrelationship of vectors of rotation

and translation is removed and a similar problem is solved for a medium having independent rotation. A region occupied by an isotropic plate with thickness 2h is weakened by a series of transverse cylindrical cavities. The lateral surfaces are perturbed by applied oscillating forces. The plate ends are free of external forces. Relationships are derived between the amplitudes of components of non-symmetric tensors of force and inertial stresses and the components of vectors. The solutions derived have sufficient functional randomness to satisfy boundary conditions on the lateral cylindrical surfaces of cavities which weaken the plate. References 5 (Russian). [284-8617]

THE PHENOMENON OF SELF-SYNCHRONIZATION IN HIGH-SPEED GYROSCOPE BEARINGS

ZHURAVLEV, V. F. and LAPIN, A. A., Moscow

[Abstract] A gyroscope system consisting of a rotor with two degrees of freedom for linear translational motion in a radial plane and two sets of ball bearings with races for each of the bearings is analyzed to elucidate the new phenomenon of self-synchronization of the motion of the rollers in the bearings. The set of balls in the bearing with the race has one degree of freedom with respect to the stationary ring. It is traditionally assumed that the race with the balls does not have its own degree of freedom and ro- tates at a fixed rate; taking this additional degree of freedom into account means that with hydrodynamic contact, the balls can slide through and the speed of the race may not coincide with the kinematic value, and will be de- termined by the balance of forces acting on the rolling bodies. Differential equations of motion are written and solved for this system, and it is shown that two steady-state modes are possible: the motion of one race can entrain the motion of the other so that they move at the same velocity, i.e., there is no slip-through in one of the bearings; or both bearings can exhibit slip- through. Some of the consequences of this phenomenon are increased wear on the rolling bodies, "spin" instability of the balls and the existence of low- frequency oscillatory processes. Analytical expressions are derived for the range of existence and stability of these periodic modes. Figures 6; refer- ences 2 (Russian).
[8225-398]

ON PERTURBING MOMENTS IN A FLOTATION GYROSCOPE ON A VIBRATING BASE

ANDREYCHENKO, K. P., Saratov

[Abstract] A cylindrical or spherical float housing contains the rotor of a gyroscope motor; the small radial gap between the walls of the float and the chamber of the instrument is completely filled with a viscous, incompres- sible fluid. It is assumed that the float housing, rotor and instrument

housing are absolutely rigid, and the force of gravity can be neglected. The instrument housing executes a reciprocating, sinusoidal steady-state vibration and the equations of motion of the rotor are written and solved, taking into account the inertial effects in the supporting layers of the fluid. Three specific cases are analyzed: a cylindrical float in a cylindrical chamber where the effects at the end faces of the float are disregarded; a spherical float in a spherical chamber; and a cylindrical float in a cylindrical chamber in the case of linear vibrations of the support. Sample calculations are given for an integrating gyroscope and a gyrotachometer with electrical dampling. Figures 3; references 7 (Russian).
[8225-398]

ON THE QUASI-STEADY-STATE MOTIONS OF A HEAVY GYROSCOPE IN GIMBAL MOUNT

SAMSONOV, V. A., Moscow

[Abstract] A heavy, axially symmetric body is mounted in a perfect cardan suspension, with the vertical axis secured to the outer ring of the suspension and the horizontal axis secured to the inner one. It is assumed that other forces besides the force of gravity act on the body and the support rings, for these forces are reduced to generalized form and used in this fashion in a qualitative analysis of the behavior of the system. Such systems can have a manifold of steady-state motions among their own motions, in which the body executes a regular precession. The dissipative factors inherent in actual systems can be broken down into two types: the first type causes the trajectories to go out to the neighborhood of the manifold of steady-state motions; the second type leed to the motion of the mapping point along the steady-state motion manifold, to so-called quasi-state motions. These motions are initially analyzed for the case of weightless gimbal frames and then the influence of the weight of the support rings on the nature of the quasi-steady-state motions is considered. Qualitative results are discussed and depicted graphically. Figures 9; references 6 (Russian).
[8225-398]

SELECTIVE ABSORPTION AS A MEANS OF INCREASING THE EFFICIENCY OF HIGH TEM-
PEPATURE SOLAR POWER PLANTS

KUDRIN, O. N., ABDURAKHMANOV, A. and AGGEYEVA, I. A., Moscow

[Abstract] The use of a spectrally selective absorption receiver can re-
sult in increasing the operating efficiency of solar power facilities. This
is of interest to the optimization of the solar power plant (SPP) with allow-
ance for the position of the vehicle in space (distance from the sun), as
then the heating temperature can be selected as a function of both the pre-
cision of the focusing mirror used and the characteristic of the selectivity
absorbing surface (chiefly of its threshold wavelength), in relation to the
use of a Stirling engine. In this connection, an energy balance equation
for a Stirling-engined SPP in relation to an ideally selective surface is
derived. It is shown that the efficiency of solar-thermal rocket engines
can be similarly increased on using a selectively absorbing surface. This
's demonstrated with respect to the problem of transferring an artificial
earth satellite from a low circumterrestrial orbit to a stationary diurnal
(synchronous) orbit. It is in the heating of surface without any signifi-
cant drainage (recovery) of heat, however, that the selectivity effect of-
fers the most interesting possibilities. This may assist in the conduct
of high-temperature physical or chemical experiments and in the adjustment
of a technological process at a stage when high productivity is not yet re-
quired. Figures 5; references 4: 3 Russian, 1 Western.
[411-1386]

ESTIMATION OF WIRING MASS AND REQUIRED VOLTAGE LEVEL IN LARGE ORBITING
SOLAR BATTERIES

CHERKASSKIY, A. KH., All-Union Order of Labor Red Banner Scientific Research
Institute of Current Sources

[Abstract] In view of the prospects for placing in orbit large solar elec-
tric power plants, the mass of the principal solar-battery (SB) components,
and in a particular the anticipated mass of current-carrying conductors was
estimated, and hence also the required voltage level at the output terminals
of SB was estimated. On the basis of a formula for the voltage drop in AC
wiring of a solar power generator, and assuming that the wiring is made of
copper, the density of the wiring is estimated at 10,000 kg/cu m, and the
critical current density is correspondingly estimated to be $3.9 \cdot 10^6$ a/sq m.
A plot of the minimum required voltage (MRV) at SB terminals as a function
of the area of a SB wing is presented, showing that the MRV should be marked-
ly greater than the currently achieved level in SB (30 v). E.g. for SB with
an area of 1000 sq m the MRV should be roughly tripled, while for SB with
an area of 10^6 sq m it should be increased to several kilovolt. Figures 3;
references 4: 1 Russian, 3 Western.
[411-1386]

A HIGH-VOLTAGE MULTIJUNCTION PHOTOVOLTAIC SOLAR CELL

DOROSHENKO, V. G., ZAKS, M. B., KALASH'YAN, V. A., LOZOVSKIY, V. N.,
SKOKOV, YU. V., and SOLODUKHA, O. I., Krasnodar

[Abstract] The possibility of developing a high-voltage multijunvtion pho-
tovoltaic cell (HMPC) based on a single crystal with multiple vertical p-n
junctions formed by heavily doped zones at right angles to the illuminated
surface of the instrument is demonstrated. A laboratory technology for
producing HMPC based on the zone recrystallization method with a tempera-
ture gradient and linear zones is presented. The investigated variant of

HMPC was made of n-type silicon with resistivity of 1 ohm·cm in which are formed vertical p^+ type zones doped with aluminum or an aluminum-boron alloy. The width of the vertical p^+ zone and the interzonal distances vary from 50 to 150 µm and from 0.2 to 4 mm, respectively. The performance of HMPC (with 11 and 5 vertical p-n junctions) was experimentally investigated in the presence of 400-500 ms light pulses from a DSSh-500 xenon lamp with a near-solar spectrum (pulse frequency 0.5-5 Hz), and the current-voltage characteristic of the HMPC was found to be then virtually unaffected. Figures 5; references 3 (Russian).
[411-1386]

THERMODYNAMIC ANALYSIS OF THERMOPOWER SOLAR ENERGY CONVERTERS OPERATING IN TANDEM WITH PHOTOVOLTAIC CELLS

BAZAROV, B. A. and TAIROV, B. D., Physico-Technical Institute, Turkmen SSR Academy of Sciences

[Abstract] Freon turbines of up to 10 kW can be designed for solar energy concentrators of 10 m diameter (or for a group of mirrors with the same surface area). Thermopower plants operating on the basis of such turbines can be expediently used in tandem with photovoltaic solar cells. The advantages of such combined facilities include the possibility of their rapid start-up directly after sunrise. In this connection, the thermodynamic efficiency of elementary freon-type steam-turbine plants used in solar energy conversion was analyzed by the entropic method and was found to be lower than the efficiency of present-day heating and power plants operating on fossil fuel. It should be borne in mind, however, that increasing the discharge rate of freon vapors and combining two types of converters--thermopower and photovoltaic--will make the freon turbine cost-competitive with the conventional steam turbine. Figure 1; references 4 (Russian).
[411-1386]

DEVELOPMENT OF SOLAR BATTERIES FOR THE INTERPLANETARY SPACECRAFT VENERA-9
AND VENERA-10 [VENUS-9 AND VENUS-10] FOR THE LUNOKHOD [MOONWALKER] PROGRAM

DALETSKIY, G. S., KAGAN, M. B., KOLTUN, M. M. and KUZNETSOV, V. M., All-Union
Order of Labor Red Banner Scientific Research Institute of Current Sources

[Abstract] The use of solar batteries as a major power source in spacecraft
is marked by a number of specific features, such as the higher level of in-
sulation and higher operating temperatures, which render it impossible to
employ conventional silicon-type solar batteries. For the solar batteries
of the Moonwalker the equilibrium operating temperature is 125-145°C, and
for those operating on the Earth-Venus flight path the temperatures gradual-
ly increase from 65 to 150°C. Hence it was necessary to develop a silicon-
type solar cell operating at a lower equilibrium temperature compared with
its conventional counterparts, regardless of the insulation level. This
was accomplished on adapting the design of parallel modules by applying a
grid of highly reflecting metal--aluminum or silver--to the reverse side of
the protective glass pane, thus assuring 84-94% reflection of solar radia-
tion. The equilibrium temperature of such solar batteries was thereby low-
ered by 30-35°C. In addition, solar batteries based on gallium arsenide,
with its greater forbidden-band width than that of silicon, were developed
for the Lunokhod-I and Lunokhod-II moonwalkers. For Lunokhod-I the result-
ing solar battery functioned satisfactorily over a period of 10 lunar days,
and for Lunokhod-II, over the entire scheduled period of 5 lunar days.
Figures 5; references 11: 6 Russian, 5 Western.
[411-1386]

OPTIMIZATION OF THE ENERGY PARAMETERS OF WIDEBAND DISTRIBUTED UHF POWER
AMPLIFIERS

GELLER, V. M. and PANDZHAKIDZE, D. A., Novosibirsk Electrotechnical Insti-
tute

[Abstract] The optimization of the des   of a type of high-power ($\leqslant$ 1 kw)
multistage wideband aperiodic amplifiers used at frequencies of 500-600 MHz
is discussed. Considering that multistage aperiodic amplifiers (MAA) are
characterized by a cumulative unidirectional flow of power which results in
some system inhomogeneity, the optimization of MAA can be based on the prin-
ciple of the inverse connection of amplifier elements (AE). Then the energy
contribution of the AE in the left-hand sections of the system increases,
which results in a rise in the integral efficiency of the system. It is
shown that optimal control of attenuation in the exciting line results in
activating within the system the number of AE that is close to the optimum
in UHF MAA with normally connected AE and assures a power level of the order
of 0.5 kw. Figures 2; references 12 (Russian).
[409-1386]

NON-UNIFORMITY AND IONIZATION MECHANISM OF THE NITROGEN PLASMA GENERATED
BY ELECTRODELESS CAPACITIVE HF DISCHARGE IN THE PRESENCE OF MODERATE PRES-
SURES

BERDICHEVSKIY, M. G. and MARUSIN, V. V., Novosibirsk, Institute of Physico-
Chemical Foundations for the Processing of Mineral Raw Materials, Siberian
Division of the USSR Academy of Sciences

[Abstract] The parameters of nonequilibrium molecular plasma generated by
electrodeless capacitive high-frequencies (ECHF) discharges are estimated
on the basis of the steady-state balance of the populations of vibronic
levels. Concentrations of metastable molecules, nitrogen atoms, the de-
gree of vibrational excitation of the fundamental state of the N_2 molecule,

and the energy distribution function of electrons in the high-energy region were used as the criteria for assessing the degree of nonequilibrium and the mechanism of ionization of the nitrogen plasma of ECHF discharge. It is shown that with approach to atmospheric pressure the vibrations and dissociation reach an equilibrium with the gas temperature. The mechanism of ionization is linked to the collisions of metastable nitrogen atoms with each other or with oxygen atoms (in nitrogen plasma treated with 0.2% oxygen), which points to the need to revise theory so as to allow for the dissociation balance and the electron energy distribution functions in the low-energy region of the excitation thresholds of metastable atoms. Figures 5; references 27: 18 Russian, 9 Western.
[409-1386]

PRINCIPAL PARAMETERS OF A ROTATING PLASMA RING IN CROSSED MAGNETIC AND ELECTRICAL FIELDS

SULYAROV, N. YU. and ZUL'FIKAROV, M. N., Samarkand State Architectural Construction Institute imeni Mirzo Ulugbek

[Abstract] Devices with annular plasma formations are often used in various technological processes. Experimentally, these formations can be generated by exciting an arc discharge between two annular plane-parallel electrodes by means of an external emf. The discharge then is moved by a magnetic field along the electrodes, following a closed circular trajectory. Considering that the behavior of the resulting plasma ring is largely determined by the interaction between the discharge and the crossed electrical fields, that interaction is now investigated. On the basis of the derived formulas for magnetic field intensity and current density, with allowance for such factors as the mean collision times between neutral particles as well as between a neutral particle and a ion, it is shown that the rotational rate of motion of the discharge is directly proportional to magnetic field intensity in the case of weak magnetic fields. In the presence of strong magnetic fields that rate reaches its maximum and subsequently asymptotically approaches the ratio E/B, where B is the magnetic field intensity and E is complete elliptic integral for a field generated by two magnetic coils. Figure 1; references 2 (Russian).
[409-1386]

THE STRUCTURE OF PROCESS AUTOMATIC CONTROL SYSTEMS FOR THE 800 MW POWER
UNITS OF THE ZAPOROZH'YE REGIONAL ELECTRIC POWERPLANT

DUEL', M. A., ZAK, I. D., KHAIT, YA. G., candidates of technical sciences,
and SOLODOVNIKOV, V. N., engineer, Central Scientific Research Institute
for Combined Automation; Zaporog Regional Electric Powerplant

[Abstract] The creation and introduction of the process automatic control
system used with the 800 MW power units of the Zaporozh'ye Regional Elec-
tric Powerplant is used as an example to demonstrate how comprehensive analy-
sis of the tasks performed by a process ACS can be used as the basis for
design of a system, considering the actual reliability of the hardware under
operating conditions, thereby simplifying the structure of the ACS. This
increases the reliability of the ACS while decreasing the expenditures of
funds, labor and hardware in the development and introduction of the ACS
and increases system flexibility. The standard set of computer hardware
called for by Teploelektroproekt Institute was poorly suited for the operat-
ing conditions as the powerplant: it included magnetic disk drives, which
are unreliable under industrial conditions, and was not well suited to the
remainder of the powerplant ACS. Therefore, a new system was designed.
The tasks to be performed by the ACS associated with each power unit were
divided into 3 groups as a function of information volume and arrival rate,
complexity of algorithms and required reliability. Each of these groups
represented a separate level in the hierarchical structure of the process
ACS. The first group included the most important tasks, such as collection
of information from censors, testing of analog and discrete quantities:
these tasks were performed by specialized computer devices; the second
group included rapid processing of information for immediate control and
storage of data. These tasks require very rapid computation and elimina-
tion of redundant data: these tasks are performed by the M-6000 computer
system without the use of external storage; finally, the third group in-
cluded tasks involving off-line processing of information, calculation of
technical and economic indices for daily, weekly and monthly reports and
processing of data generated by equipment testing. This group of tasks in-
volves the processing of large volumes of information by complex programs,
but the required speed of computation is not as great. As for the second
group of tasks: this group of tasks was performed by the M-6000 computer
system, utilizing peripheral storage. Figures 2; references 2 (Russian).
[388-6508]

PROMISING FUELS FOR MHD ELECTRIC POWERPLANTS

KRUZHILIN, N. A., candidate of physical and mathematical sciences, ROTINOV,
A. G., engineer, TAGER, S. A., candidate of technical sciences, and YAKUBOV,
I. T., doctor of physical and mathematical sciences, Institute of High Tem-
peratures, USSR Academy of Sciences

[Abstract] A study is made of the influence of the primary characteristics
of the main types of organic fuel on the indices of the plasma produced at
MHD powerplants. Types of fuels are classified according to content of vari-
ous elements and radicals, specific heat content, conductivity of the plasma
generated, reactivity, moisture and ash content, carbon/hydrogen ratio, and
an analysis of the comparative prospects for the use of various fuel types
is presented. Coal is considered to be the most promising type of fuel for
large condensation powerplants, and quite promising for MHD powerplants as
well, although a number of problems remain to be solved. Figures 5; refer-
ences 5 (Russian).
[367-6508]

CALCULATION OF THE MOVEMENT OF RELATIVISTIC BEAMS OF CHARGED PARTICLES IN
ELECTROMAGNETIC FIELDS

ASTRELIN, V. T. and SVESHNIKOV, V. M., Novosibirsk

[Abstract] A study is made of axisymmetrical problems in which the electric
field potential satisfies Poisson's equation in a closed region. Boundary
conditions of the first or second kind are assigned for the potential along
parts of the boundary of the region. Within the region there may be internal
interfaces of two media with different dielectric constants. Algorithms are
presented which are compatible with the subroutine library of the BESM com-
puter system. Calculations using the algorithms presented indicate that
significant focusing of electrons occurs under the influence of the azimu-
thal magnetic field of the beam itself. The angular dispersion of electrons
reaches $60°$. The calculated full current of the diode is 100 kA, which agrees
well with theoretical estimates. Figure 1; references 17: 13 Russian, 4
Western.
[312-6508]

USSR

SUPERPOWER ENGINEERING: SUPERPOWERFUL MACHINES, SUPERCONDUCTING CABLE, SUPERCAPACITY ENERGY STORAGE DEVICES

PATRUNOV, F., Correspondent, and GLEBOV, I. A., Director, All-Union Scientific Research Institute of Electric Machine Building

[Abstract] In this intervi.. I. A. Glebov discusses some of the latest developments in superpower engineering. Some of the problem encountered in operation of such devices as 800 MW generators are briefly discussed. Color photographs are pre: r.ed of some of the devices to be found in the laboratory of the Institut.. Among the most difficult problems have been casting of rotors for 1200 MW electric machines, since they are quite massive--230 tons, and compensation for vibrations in large electric machines and generators. The problem of increasing the power output for machines of essentially approximately the same size results in lower stability of machines, and this lower stability is blamed for the 1965 northeast power blackout in the USA. Glebov states that the generators of the future will be 3000 MW superconducting machines with liquid helium cooled rotors. Superconducting cables will also soon be used to transmit large quantities of power. A new trend in peak power production is the storage of energy in superconducting energy storage devices, such as a superconducting coil 300 meters in diameter and approximately 100 meters high. Calculations show that this coil could store 10^{13} J of energy, and output 2500 MW of power during the few peak hours of the day. The tremendous current flowing through the conductor would generate electrodynamic forces which would attempt to destroy it. Therefore, the superconducting energy storage ring is to be built in rock. Preliminary calculations show that such a storage device could achieve the same efficiency as a pump-storage hydroelectric power plant. Power sources predicted for the future include MHD generators with superconducting exciter windings and thermonuclear fusion devices. Glebov does not believe that the "hydrogen economy" of energy transportation and use is practical for the foreseeable future.
[423-6508]

THE BGR-300 NUCLEAR REACTOR THERMAL SYSTEM AND SUPERCRITICAL STEAM G'ENERATOR

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candidates of technical sciences, All-Union Institute of Heat Engineering;
Special Design Bureau, All-Union Institute of Heat Engineering

[Abstract] The BGR-300 300 MW fast reactor is being developed as a pilot
model. Considerations of economy and safety lead to the recommendation of
the K-300-240 turbine produced by the Leningrad Metal Plant as the power
turbine for this reactor. This article recommends a design for the entire
thermal circuit for the reactor, using super-critical steam parameters in
order to increase economy and decrease emission of heat into the environment.
A diagram of the steam generator recommended is presented. Figures 5.
[367-6508]

SOME PROBLEMS IN USING AN ASYMMETRIC SYSTEM FOR REACTOR CONTROL

YEMEL'YANOV, I. YA., PODLAZOV, L. N., ALEKSAKOV, A. N. and PANIN, V. M.

[Abstract] The authors analyze the operation of an asymmetric control sys-
tem that is based on spatially separated measurement and recording elements.
This type of system stabilizes the energy-release field that is appreciably
unstable when there are no external feedbacks. The response of an asymmetric
control system to an external perturbation causes deviations of the shape of
the field from the initial shape, and the time of the transient process ex-
ceeds the time constant of the longest-period process by a factor of 7-8.
There is also a variation in the overall reactor power.

A combined system that includes an asymmetric controller and a total power
regulator stabilizes the field and simultaneously keeps the total power
constant, but there are still considerable deviations from the original shape
of the field, and the response time is still about triple the time constant
of the longest-period process.

A system based on the principle of localized control is much more efficient.
The effect of a perturbation is localized in such a system, the response
time is reduced by a factor of 1.5 and the amplitude of the maximum deviation

of the neutron flux is reduced by approximately an order of magnitude as compared with the combined system. Further optimization should be based on localized regulators with partial asymmetry provided by the configuration of sensors and control units. Figures 7; references 6: 4 Russian, 2 Western. [392-6610]

THE KAL'MAR-1 PULSED ELECTRON ACCELERATOR WITH POWER DENSITY OF RELATIVISTIC ELECTRON BEAMS UP TO $5 \cdot 10^{12}$ W/cm^2

DEMIDOV, B. A., IVKIN, M. V., PETROV, V. A. and FANCHENKO, S. D.

[Abstract] Controlled nuclear fusion based on relativistic electron beams requires a beam with current of the order of 10^7 A, and power density in the beam of 10^{13} W/cm^2. The authors describe the Kal'mar-1 accelerator that produces a relativistic electron beam with power density of $5 \cdot 10^{11}$-$5 \cdot 10^{12}$ W/cm^2. Investigations are made of focusing of the relativistic beam in a high-voltage diode as a function of electrode geometry and the magnitude of the preliminary voltage pulse. The beam current of the accelerator is 500 kA, electron energy is 1 MeV, and pulse durating is 10^{-7} s. A double shaping line is charged by a pulse voltage generator with output of 2 MV and initial capacity of 70 kJ. The equivalent electric circuit for charging the accelerator is discussed. Experimental results are given on beam focusing for a current of up to 200 kA and electron energy of 0.5 MeV. It is shown that a simple design without additional peaking switches keeps the prepulse amplitude down to 1%, and the use of conical metallic cathodes gives relativistic electron beam power density up to $5 \cdot 10^{12}$ W/cm^2. Figures 7; references 14: 7 Russian, 7 Western. [392-6610]

A NON-CONTACT METHOD OF STUDYING THE THERMAL STATE OF FUEL ELEMENTS IN THE
PROCESS OF IRRADIATION

MURASHOV, V. N., KOKOREV, L. S. and YAKOVLEV, V. V.

[Abstract] The thermophysical properties of fuel elements may change con-
siderably during exposure to radiation. In the initial period of exposure
the temperature in the center of the elements rises for the first 100-300
hours, and then begins to fall with continued operation at constant power.
The authors propose a non-contact method of checking the thermal state of
fuel elements during prolonged operation. The technique is based on using
the unsteady working conditions when there are stepwise power changes, shut-
downs, operations of the scram system and power fluctuations. The sensors
are a neutron flux detector in the fuel assembly and a thermocouple in the
coolant at the outlet from the core. The relation between perturbations of
the coolant temperature and perturbations of the linear heat load on the
fuel assembly is found by solving a system of energy equations for the cool-
ant and the fuel element. Experiments show that as a result of prolonged
operation in the region of high thermal loads, the fuel element reaches a
state in which the thermal resistance of the fuel-cladding interface becomes
negligibly small compared with the total thermal resistance. The results
are in qualitative agreement with data in the literature on the behavior of
oxide fuel. Figures 3; references 6: 4 Russian, 2 Western.
[392-6610]

INVESTIGATION OF THE KINETICS OF PROMPT NEUTRONS IN A SYSTEM WITH A CAVITY

CHISTOZVONOV, A. S., MATVEYENKO, I. P., POLIVANSKIY, V. P. and VLADYKOV,
G. M.

[Abstract] An experimental study was done on the kinetics of prompt neutrons
in a system made up of two identical breeder assemblies. The assembly was
a thin-walled steel tank measuring 150 x 600 x 785 mm filled with an aqueous
solution of uranium salt. The uranium concentration in the solution was 36.1

grams per liter, and uranium enrichment was 90%. The distance between tanks could be varied from 0 to 1200 mm. A pulsed neutron emitter with neutron energy of 14 MeV was placed in direct contact with the outside of one of the tanks at the middle of its height. The neutron detectors were SNM-12 counters. The detectors were located in each tank and in the cavity between them. The data were processed by computer. It was found that neutron decay is approximated by exp $(-\alpha t)$. The settling time is in a range of $1/\alpha - 5/\alpha$ depending on the relative location of the detector and the neutron source. Systems with cavities show a faster rise in the time of neutron production with decreasing K_{eff} than systems without a cavity. The pulsed α-method of determining reactivity can be successfully used in studying systems with a large cavity. References 4: 2 Russian, 2 Western.
[392-6610]

NEUTRONS EMITTED BY FRAGMENTS OF SPONTANEOUS FISSION OF ^{252}Cf AND THERMAL FISSION OF ^{239}Pu

BASOVA, B. G., RYAZANOV, D. K., RABINOVICH, A. D. and KOROSTYLEV, V. A.

[Abstract] The distributions of momenta and neutron numbers are found as functions of mass and kinetic energy for fissile nuclei of ^{252}Cf and ^{240}Pu that differ considerably in nucleon makeup, and also the fragments are found that emit the largest number of neutrons. An analysis is made of events with maximum and minimum neutron yield in spontaneous fission of ^{252}Cf and thermal fission of ^{240}Pu. An estimate is made of the maximum deformation of light and heavy fission fragments. Figures 4; references 14: 6 Russian, 8 Western.
[393-6610]

OPTIMIZING A SYSTEM OF DIRECT ENERGY CONVERSION WITH PARABOLIC CHARGED
PARTICLE TRAJECTORIES

DIMITROV, S. K. and MAKHIN, A. V.

[Abstract] An examination is made of the problem of optimizing the parame-
ters of the oblique diaphragm system proposed earlier for direct conversion
of the energy of reactor ion beams [O. A. Vinogradova et al, ATOMNAYA ENERGIYA,
Vol 33 No 1, 1972, p 586]. This system is intended for use in fusion reactors
of open-ended mirror configuration and injector tokamaks. A refined technique
is proposed for optimizing the cutoff angle of the collecting diaphragms with
consideration of secondary emission from the diaphragm. An examination is
made of the direct conversion of energy of positive ions (with and without
compensation of the ion space charge by electrons), as well as negative ions
and electrons. The theoretical results agree with experimental data. Maximum
efficiency of direct conversion in the optimum case is near 95% for a beam
with ratio of 0.05 between the beam diameter at input to the deceleration re-
gion and the Debye electron radius. Figures 4; references 2 (Russian).
[393-6610]

ON THE FEASIBILITY OF INCREASING THE 'HOT' NEUTRON FLUX ON THE IVV-2 REACTOR
BY USING A RETHERMALIZER

GUSEV, V. V., GOSHCHITSKIY, B. N., YEFANOV, A. I., MESROPOV, M. G., POLO-
SUKHIN, B. G. and chudinov, v. g.

[Abstract] The percentage of "hot" neutrons ($E = 0.1-0.5$ eV) in the spectrum
of thermal neutrons coupled out of reactor channels is low. Since hot neu-
trons are used in diffraction experiments to study the structure of matter,
the authors consider the use of a rethermalizer (a moderator block heated
to high temperature) for shifting the average neutron energy to higher
levels. A hot neutron source is proposed that consists of a vacuum-insulat-
ed tank with a rethermalizer made of zirconium hydride layers with thickness
ranging from 10 to 50 mm in 10 mm steps. The temperature of the rethermalizer

was automatically held at a predetermined level. Heating to 600°C provides an absolute increase in neutron flux density by a factor of 1.2-4.3 depending on the value of E in the range from 0.1 to 0.2 eV. The neutron temperature in the extracted beam is estimated at 600-650 K. The authors thank N. A. Dollezhal' for continuing interest in the work, A. G. Chudin for constructive criticism, and A. N. Baleyevskikh and V. I. Shcherbakov for assisting with the measurements. Figures 2; references 10: 5 Russian, 5 Western.
[393-6610]

ROTATIONAL STABILIZATION OF A CORKSCREW INSTABILITY IN A PLASMA WITH FIXED BOUNDARY

GUTKIN, T. I., TSYPIN, V. S. and BOLESLAVSKIY, G. I.

[Abstract] Previous research on the influence that rotation has on a corkscrew instability in plasma with fixed boundary has shown that rotation stabilizes the instability when $c_{A\phi}/a \leq \Omega \leq \sqrt{2}(c_{A\phi}/a)$, where Ω is the rotational velocity of the plasma, $c_{A\phi}$ is the Alfven velocity with respect to the azimuthal magnetic field, and a is the radius of the plasma. This result was found in the incompressible plasma approximation, and is applicable only for the speed of sound $c_s \to \infty$. In this paper the authors examine the case of finite c_s. A cylindrical plasma column of radius a is considered in a constant longitudinal magnetic field B_{0z} surrounded by an ideally conductive jacket of the same radius. The current flowing through the plasma column sets up an azimuthal magnetic field $B_{0\phi}(a)\frac{r}{a}$ inside it. The plasma column rotates at velocity Ω = const. The authors consider perturbations of the type $\sim \gamma(r) \exp[i(-\omega t + k_z z + m\phi)]$. The analysis is based on a system of equations of ideal one-fluid hydrodynamics, and the problem of stability of the rotating plasma column with current is reduced to examination of a certain differential equation. It is shown that under certain conditions rotation can stabilize a corkscrew instability in a plasma with pressure that is not too high. References 6: 5 Russian, 1 Western.
[393-6610]

COMBINED USE OF NUCLEAR AND FOSSIL FUEL IN STEAM-GAS FACILITIES

NOSACH, V. G. and PUSHKAREV, O. YE.

[Abstract] A disadvantage of steam-gas facilities is the necessity for using ash-free fuel. Combined use of nuclear and fossil fuels saves natural gas and gives high economy in electric power generation. The percentage of nuclear fuel increases if the fossil fuel for production of hydrogen and carbon monoxide is subjected to heat treatment (conversion) with oxidizers such as water vapor and carbon dioxide. The fraction of nuclear fuel was calculated previously for steam conversion of methane [V. G. Nosach, P. L. Yevtushenko, DOKLADY AKADEMII NAUK UkrSSR, SERIYA A, No 2, 1977, p 177]. In this paper the authors do the corresponding calculation for the case of methane conversion by heat treatment with combustion products. Calculations show that the percentage of nuclear heat without the use of fuel conversion is considerably less, this difference reaching a maximum of 18% at a temperature of 1000-1100 K. The results confirm effectiveness of the combined use of nuclear and fossil fuels in steam-gas power plants with conversion of the fossil fuel. The chemical treatment of natural gas with combustion products increases the percentage of nuclear fuel by at least 10% over the use of water vapor. Figures 2; references 4 (Russian).
[393-6610]

NEUTRON-PHYSICS CHARACTERISTICS OF REACTORS OF THE BILIBINO HEAT AND ELECTRIC NUCLEAR POWER PLANT (BASED ON RESULTS OF PHYSICAL STARTUPS OF FOUR REACTORS)

VAYMUGIN, A. A., DUSHIN, P. G., KOMISSAROV, O. V., KOSTROMIN, A. G., LOGOSHA, N. I., LYUBCHENKO, V. F., MINASHIN, M. YE., SOLDATOV, G. YE. and SHARAPOV, V. N.

[Abstract] The paper gives the results of a neutron-physics study of four reactors at the Bilibino nuclear heat and electric plant. Neutron-physics characteristics were measured during physical startups. Data are given on charging the reactors with fuel and on the values of reactivity excess, which are about 11% of the K_{eff} in the cold state of the reactors with

water in the fuel channels. The characteristics of the reactivity compensation and scram system of the reactors are given. Subcriticality in the cold state when all control rods are in the core is 0.013 for the first two reactors, and 0.02 for the other two. The efficiency of the scram rods is 0.014. The temperature effect of reactivity measured in the temperature range from 24 to 104°C is $4.5 \cdot 10^{-3}$. The neutron-physics characteristics were found to be the same for all four reactors, and to agree with calculations. The number of compensating rods in the critical state is somewhat greater in the first reactor due to the greater charge of uranium, and it is expected that its run will be somewhat longer. Figures 4; references 7 (Russian).
[394-6610]

PHYSICAL STARTUP OF THE IBR-2 PULSED RESEARCH REACTOR

ANAN'YEV, V. D., ARKHIPOV, V. A., BABAYEV, A. I., BLOKHINTSEV, D. I., deceased, BULKIN, YU. M., BUNIN, B. N., VOROB'YEV, YE. D., DOLLEZHAL', N. A., YEDUNOV, L. V., LAVRUKHIN, V. S., LOMIDZE, V. L., MELIKHOV, V. V., MITYAYEV, YU. I., PEPËLYSHEV, YU. N., PLASTININ, V. P., ROGOV, A. D., SMIRNOV, V. S., FRANK, I. M., KHRYASTOV, N. A., SHABALIN, YE. P. and YAZVITSKIY, YU. S.

[Abstract] A review is presented of the major experiments done in physical startup of the IBR-2 pulsed research reactor at Dubna in late 1977 to early 1978. The reactor was first brought up to the critical state on delayed neutrons on 30 November 1977, and pulsed criticality was reached on 13 January 1978. Neutron-physics studies during a dry startup (without coolant) confirmed the possibility of realizing the main design characteristics of the reactor as a neutron source for physics research. The characteristics covered in the study included the effectiveness of the reactor control system and of individual elements of the reactor, the lifetime and space-energy distribution of neutrons, pulse shape and duration, and also fluctuations of reactor power. Discrepancies of some physical parameters are due to the failure to account for auxiliary elements of the reactor in calculations. Figures 11; references 5 (Russian).
[394-6610]

A NEW METHOD OF DETECTING BOILING WATER IN A REACTOR

ZAKHARKIN, I. I.

[Abstract] The author proposes an optical method of detecting boiling water in a reactor core based on the effect of Cherenkov radiations of electrons in water [Soviet Patent No 448770]. It is shown that the intensity of the Cherenkov effect in the vapor phase is considerably lower than that in water, and can be disregarded. Thus the intensity of emission is proportional to the fraction of water in the steam-water mixture. Hollow metallic light guides can be used to couple the light out of the region that is being monitored. At the output from the light guide, the signal can be registered by an appropriate sensor to give the required information. Figures 2.
[394-6610]

ENERGY DISTRIBUTION OF GAMMA RADIATION OF ^{235}U FISSION PRODUCTS WITH SHORT EXPOSURE TIME

MARKINA, M. A., STARIZNYY, YE. S. and BREGER, A. KH.

[Abstract] Experimental studies are done on the gamma spectra of ^{235}U fission products when fuel is held in the reactor core for times up to 10 hours, and storage times of up to 10^7 s. Curves are given showing the time dependence of specific power of gamma radiation of fission products in various energy ranges at different exposure times, and also for the average energy of the energy spectrum as a function of storage time, which characterizes the exposure doses when fission products are used as sources of gamma emission. The authors thank A. S. Gerasimenko for assistance with the work. Figures 2; references 8: 5 Russian, 3 Western.
[394-6610]

RESONANCE INTEGRAL OF NEUTRON CAPTURE ON ^{244}Pu

DRUZHININ, A. A., KRYLOV, N. G., LBOV, A. A., ODINTSOV, YU. M. and SUMATOK-HIN, V. L.

[Abstract] To choose the optimum method of getting nuclides of transplutonium elements by the reactor technique, it is necessary to know the cross sections of neutron reactions for all nuclides in the accumulation chain. Therefore the authors measure the resonance integral of neutron capture on ^{244}Pu. Plutonium nitrate solutions in quartz vials were exposed in a reactor channel. The resonance integral for the reaction ^{244}Pu$(n,\gamma)^{245}$Pu was measured by the cadmium ratio method by comparing with the known resonance integral for the reaction ^{197}Au$(n,\gamma)^{198}$Au. The cadmium ratio was defined as the ratio of the specific activity of the given nuclide in a specimen exposed without a cadmium shield to that of the same nuclide in a specimen exposed with a cadmium shield. For cadmium ratios on ^{244}Pu of 1.85 ± 0.15, 2.02 ± 0.20 and 1.91 ± 0.13, the resonance integral of neutron capture was 44.5 ± 8.0, 37.1 ± 6.7 and 40.3 ± 6.1 b respectively. The effective value is 40 ± 3 b. References 10: 4 Russian, 6 Western. [394-6610]

ABSOLUTE MEASUREMENTS OF THE CROSS SECTION FOR FISSION OF ^{241}Am BY 2.5 MeV NEUTRONS

ALEKSANDROV, B. M., NEMILOV, YU. A., SELITSKIY, YU. A., SOLOV'YEV, S. M., FUNSHTEYN, V. B., KHLEBNIKOV, S. V. and SHIRYAYEV, B. M.

[Abstract] In previous research, the absolute cross sections for fission of ^{238}U and ^{235}U have been measured with registration of the neutron flux with respect to accompanying particles from the reaction $D(d,n)^3$He. In this paper the authors use a somewhat modified technique for the first absolute measurements of the cross section of fission of ^{241}Am by 2.5 MeV neutrons.

The modification was in the use of a semiconductor surface-barrier silicon detector for helion registration rather than a gas proportional counter. The ^{241}Am targets were made by sputtering americium fluoride on a rotating aluminum disk. A total of 2117 fission events were registered and 716,205 helions. Calculations give a value of $\sigma_{nf}(^{241}Am) = 1.98 \pm 0.07$ b. References 9: 6 Russian, 3 Western.
[394-6610]

USE OF NOBLE METALS IN THE SLIDING CONTACTS OF OPTICO-MECHANICAL INSTRUMENTS

KAZAKOVA, N. N. and RABINOVICH, L. V.

[Abstract] Components with sliding electrical contacts in various optico-
mechanical devices represent not only a couple transmitting an electrical
signal but also a couple operating under complex conditions of dry or bounda-
ry friction. Hence they have to satisfy special requirements, particularly
as to the selection of materials of the contact couple, on the basis of such
criteria as the friction coefficient of the materials, the contact resistance
under static and under dynamic conditions, and the strength characteristics
of the materials. The existing methods for material selection are inadequate;
however, the optico-mechanical industry has gained practical experience in this
matter. On this basis, gold-based alloys are found to be superior to plati-
num-based alloys. A palladium-tungsten alloy has demonstrated high reliabili-
ty of performance when used in lieu of corrosion-prone nichrome for the fabri-
cation of potentiometer windings operating at high contact pressures. So far
as the fabrication of slip rings is concerned, the galvanic method of deposit-
ing noble metals--silver, gold, palladium, and rhodium-- is the most promising.
Silver and gold can be treated with other metals to increase their wear resis-
tance. E.g. while galvanic silver has a hardness of 85 kg/mm^2, treatment with
antimony increases it to 165-200 kg/mm^2; the hardness of galvanic gold is in-
creased from 100 to 240 kg/mm^2 on treatment with 20% copper. Electrolyte com-
position also is important: palladium coatings obtained from aminochloride
electrolytes display a hardness of 230 kg/mm^2 whereas those obtained from
phosphoric electrolytes have a hardness of 380 kg/mm^2. Addition of copper
to the electrolyte can further increase the hardness of palladium coatings.
The highest hardness and wear resistance are displayed by rhodium coatings
(800-900 kg/mm^2); rhodium coatings treated with nickel and tungsten have been
developed. The vibrational transport of the noble material to the base ma-
terial can be utilized in the production of slip-ring devices. For example,
the ring may be made of stainless steel and the contact, of a gold-based alloy,
which produces considerable savings of the noble metal. References 5 (Russian).
[395-1386]

COMPARISON OF THE REFRACTIVE INDEXES AND IR SPECTRA OF SILICON DIOXIDE
FILMS PRODUCED BY DIFFERENT METHODS

BALAGUROV, A. YA., PELIPAS, V. P., PETROV, V. N. and SIMONOV, B. M.

[Abstract] The use of silicon dioxide thin films in various optical systems
and especially in reflecting interference coatings necessitates determining
which fabrication method would assure the optimal properties of such films,
and also determining methods for their quality control. The authors investi-
gated the phase composition, structural features, and refractive indexes of
SiO_2 thin films produced by four different methods: 1) gas-phase deposition;
2) pyrolytic deposition from a vapor-gas mixture of monosilane, argon, and
oxygen in glow-discharge plasma; 3) pyrolytic decomposition of tetraethoxysi-
lane; and 4) electron-beam vaporization of quartz glass in vacuo. The desired
qualities, for films to be used as reflecting interference coatings, were low
absorption in the spectral operating range, high optical stability, and defi-
nite values of refractive indexes. IR-spectral analysis of the films obtained
by the four different methods showed that films obtained by method 3) displayed
the greatest structural perfection and lacked impurity phases such as Si_2O_3
which cause the refractive index of the films to increase too much. Measure-
ment of the refractive indexes of the different films as a function of the
partial pressure of oxygen in a vacuum chamber revealed that the lowest re-
fractive index also was displayed by the films obtained by the method of pyro-
lytic decomposition of tetraethoxysilane. Figures 1; references 12: 10
Russian, 2 Western.
[395-1386]

AN AUTOCOLLIMATION SYSTEM FOR QUALITY CONTROL OF THE PROFILES OF ASPHERICAL PLANOID SURFACES

LUSTBERG, E. A., BUBIS, I. YA. and PETROVA, L. A.

[Abstract] The use of high-precision aspherical components in optical systems is restricted by the complexity of their fabrication as well as by the relative lack of knowledge about their properties and design techniques. It is now proposed that the quality of fabrication of such components, and in particular of the slanted aspherical planoid mirror that is part of the optical lens system can be checked with the aid of an autocollimation system on using a single optical element--a concave spherical reference mirror with a radius of curvature differing from that of the spherical mirror entering into the lens system. This assures complete compensation of aberrations of the mirror being checked with the aid of just one optical element. Its principal components are: an interferometer, a plane mirror, and a spherical concave mirror serving to convert the diverging spherical wave front originating from the interferometer source to a near-planar front directed at right angles to the profile of the aspherical mirror being monitored. The result is a convenient and simple method for the quality control of the fabrication of planoid mirrors, as a last-stage complement of the shadow method and the measuring microscope method of quality control. Figures 4; references 4 (Russian). [395-1386]

STABILIZATION OF HEAT INDICATOR TYPE POLYMER FILMS

ANDREYEV, V. M., ZHARKOVA, G. M., FOKIN, YE. P. and KHACHATURYAN, V. M., Novosibirsk, Institute of Theoretical and Applied Mechanics, Siberian Affiliate of the USSR Academy of Science

[Abstract] Liquid-crystal heat indicators based on cholesteric liquid crystals (CLC) are finding increasing application in the measurement of surface temperatures, when applied in the form of thin layers deposited on the

surfaces to be investigated. However, their properties are unstable in time as they undergo irreversible oxidation due to the oxygen of air as well as to UV radiation. In this connection, the effect of various chemical additives (antioxidants and photostabilizers) on the service life of heat indicator films based on hydrophobic polymeric binders is investigated. Of the antio-oxidants investigated (phenol compounds, aromatic oxy compounds, heterocyclic compounds--derivatives of pyrimidine and benzotriazole, and an organosilicon compound) the phenol type compound (pentamethylphenol) was found to be the best stabilizer of properties of cholesteric liquid crystals enclosed in a gas-permeable polymer. Comparison of the effect of the various stabilizers on the stability of the films indicates that the process of the aging of the CLC investigated occurs chiefly owing to oxidizing processes. The other com-pounds tests represent classical photostabilizers. Film specimens stored in darkness for a year at room temperature retained their properties longer than did specimens exposed to normal diffuse illumination over the same period, which indicates that the process of the aging of the films gets accelerated in the presence of UV radiation. Figures 3; references 9: 7 Russian, 2 West-ern.
[409-1386]

SCANNING LIGHT MODULATORS BASED ON NEMATIC LIQUID CRYSTALS

CHEREMUKHIN, G. S., ROZHNOV, V. P., ROZANOV, L. A. and SAFONOV, V. F.

[Abstract] Transmitted light modulators based on nematic liquid crystals consist of a liquid crystal film between transparent electrodes and a light-proof diaphragm with an aperture placed at some distance from the liquid crystals. The advantage of liquid-crystal modulators over magnetooptical and orthoferrite modulators is the capability to operate at angles of inci-dence of diverging light beams of up to some dozens of degrees. The scatter-ing properties of nematic liquid crystals are strongest under polarized light coinciding with the orientation of the liquid crystal molecules. The steep-ness of the scanning characteristic varies inversely with temperature and diameter of the light beam. Steepness can be further increased by installa-tion of narrow-band interference filters on the light path before the liquid crystal. Figures 2; references 9: 7 Russian, 2 Western.
[427-6508]

USSR   UDC 548.552

LARGE OPTICAL CRYSTALS OF THE FLUORIDES OF CALCIUM AND BARIUM

SOKOLOV, V. A., SIMUN, YE. A. and SINEV, A. N.

[Abstract] A crystallization installation in which the thermal field was
formed using a single tubular heater with a ratio of length to diameter of
about 2 to 1 and a system of heat insulating shields was used to grow and
anneal crystals up to 460 mm in diameter, weighing up to 60 kg. The tempera-
ture was stabilized within $\pm 1°C$, the vacuum during crystallization was about
$5 \cdot 10^{-5}$ torr and the crystallization rate was 2-3 mm/hr. Photographs of the
crystals produced are presented. The spectral transparency of the large crys-
tals in the visible and infrared regions depends little on the slight devia-
tions in purity of the raw material and conditions of technological process.
However, the spectrum of transmission in the ultraviolet region is more struc-
ture-sensitive and depends to a great deal on deviations in the quality of
the raw material and in crystallization conditions. Figures 4; references 7:
3 Russian, 4 Western.
[427-6508]

SUPERCONDUCTING MATERIALS IN MODERN ENGINEERING

CHERNOPLEKOV, N. A., doctor of physical and mathematical sciences, Chief of
Department of Solid State Physics, Institute of Atomic Energy imeni I. V.
Kurchatov

[Abstract] A brief outline of the history of studies of superconductors is
presented. The properties of superconductors are discussed and the use of
superconducting materials in engineering is briefly described. A laboratory
superconducting installation which has generated a magnetic field of 9.3-9.5
T is shown. The use of superconducting magnetic systems for scientific re-
search, including studies of subatomic particles with short lifetimes, plasma
studies in open traps, and the Tokamak-7, is illustrated. The use of super-
conducting magnetic systems power generation is briefly discussed, including
superconducting magnetic systems for MHD generators and superconducting energy

storage devices. Other trends in the use of superconducting magnetic systems
are mentioned, including very large electric machines with superconducting
windings, such as a synchrotron generator rated at 20 MVA and high-speed mag-
netic cushion railroad trains.
[429-6508]

ON STARTUP REGIMES OF OPERATION OF HYDRAULIC GENERATOR THRUST BEARINGS

TOKAR', I. YA. and URASOV, P. G., Khar'kov

[Abstract] There is currently no method of calculating the startup conditions
of thrust bearings which explains observed movement of the thrust block rela-
tive to the bearing. The authors' previous attempts to solve the nonstation-
ary lubrication problem by solving the nonstationary Reynolds equations and
energy transfer equations were unsuccessful, because the system of equations
used was incomplete. It is necessary to take into account inertia effects,
the movement of elastic chambers, deformation of the thrust block, friction
at the bearing pin and the like. The present solution of the problem is de-
signed for computer execution and ignores nonuniformity of the bearing surface.
The hydrodynamic theory of lubrication is applied to the solution. Startup
from cold condition involves different conditions from warm startup, since
forces rather than thermal deformations of the thrust block predominate. Meth-
ods exist for correcting for both conditions. Graphs showing the position of
the thrust block relative to the bearing surface as a function of time are
presented. The method was used to compare the ordinary thrust bearing design
with a design in which the center of rotation is above the friction zone (pro-
posed by Uralelektrotyazhmash); the latter design had advantages under startup
conditions with reversible machinery. Figures 2; references 7 (Russian).

THERMOELASTOHYDRODYNAMIC STUDY AND CALCULATION OF THE CHARACTERISTICS OF
THRUST BEARINGS WITH FIXED THRUST BLOCK

KHADIYEV, M. B., MAKSIMOV, V. A. and KARCHEVSKIY, M. M., Kazan'

[Abstract] Previous works have studied the thermoelastohydrodynamic charac-
teristics of slide bearings with inclined blocks and two-layer bearing seg-
ments with forced cooling. The present article analyzes the characteristics
of thrust bearings (rotating surfaces) with fixed thrust blocks. A series
of differential equations is set up for the pressure distribution, lubricant
viscosity and density as a function of temperature, temperature distribution
in the lubricant layer, heat conductivity in the block, and the shape of the
lubricant layer. These equations are solved by means of a finite-difference
method. Graphs of the temperature distribution in the lubricant layer and
in the block itself and of the bearing capability of the block as a function
of temperature are presented. Figures 5; references 9 (Russian).

CUTTING TOOLS WITH CERAMIC INSERTS

MARGOLIT, P. B., candidate of technical sciences, KURKOV, E. I. and LEYBSON,
I. YA.

[Abstract] Ceramic cutters offer the opportunity to make full use of the
capabilities of numerical-control machine tools. The Ryazan' Machine Build-
ing Production Association (RSPO) has developed cutting tools for mechani-
cally-clamped disposable inserts made of VZ or VOK-60 ceramic. The tools are
themselves machined on NC machine tools when possible. It is found that white
ceramic is preferable to VZ or VOK-60 black ceramic in machining raw steels.
Machining of shaft journals with VOK-60 ceramic produced a surface finish Ra =
1.25 microns, making grinding unnecessary. The use of 2,000 VOK-60 tips saved
23,000 rubles. Use of the ceramic in finishing and semifinishing of steel
and cast iron pieces is recommended. Figure 1.

USSR   UDC   621.914.1:669.13:669.018.95

MILLING CAST IRON WITH CERAMIC

ISSINEN, E. E., BLANK, YU. B., MAMKIN, G. I. and UGNICH, V. A.

[Abstract] A face milling cutter with a diameter of 400 mm was fitted with
inserts made of VOK-60 oxide-carbide ceramic 12.7 mm square by 4.76 mm thick,
fastened into a special element by a wedge. Of three variants of the milling
cutter tested, the best success was obtained with a design incorporating two
wiper blades; only this design gave the desired surface finish (Rz = 10 mi-
crons). The cutters were used to machine cylinder blocks made of SCh 21-40
cast iron (HB 170-241). The grinding (v = 410 m/min; s_z = 0.20 mm/tooth;
s = 1700 mm/min; t = 0.5 mm) was accompanied by vibration, indicating the
need for a rigid spindle unit and workpiece holder when using ceramics. The
deviation from flatness of the pieces did not exceed 42 microns. Some 157
cylinder blocks were machined. After 30, circular scratches were visible on
the machined surface. After machining, 12 of 26 teeth showed chipping of the
cutting edges.

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PROPERTIES OF A CUTTING TOOL WITH CERAMIC INSERTS

GAMOV, YE. P. and SOLOV'YEVA, L. G.

[Abstract] The effect of the cutting parameters on wear of the ceramics VZ
and VOK-60 was tested by turning 35Kh3NM quench-hardened steel with hardness
HRC 50. The side relief and side cutting edge angle of the tool were both
45°, the rake -6°, the end relief angle 6°, the tip radius 1.2 mm, and the
rake of the chamber -26° with a breadth of 0.3 mm. Wear was found to occur
primarily on the flank, and not at a constant speed: wear rapidly reached
0.05-0.08 mm, then rose from 0.1 to 0.3 mm more slowly. Crumbling and chip-
ping were the characteristic types of wear, and were produced by cyclic
force and heat loads. The finish of the machined surface was initially 1 or
2 classes higher than that machined by carbide cutters. As wear increased,
the quality decreased. A formula for expected tool life and formulas for
the three components of the cutting force are derived. Figures 3.

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MACHINING ROLLERS WITH CUTTING CERAMIC

SHAKHNOVICH, B. YA., KRAVTSOV, V. A. and ABDULLAYEV, V. E.

[Abstract] In the machining of rollers from quench-hardened 45 steel (HRC 45-50), mechanically clamped inserts of el'bor-R gave a surface finish Ra = 0.8 micron; geksanit-R gave a finish of 0.9 micron, while VOK-60 gave a finish of 0.3 micron at v = 60 m/min and 0.8 micron at 120 m/min, with a feed of 0.138 mm/rev in both cases.

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MACHINING OF BUSHINGS WITH CERAMIC-TIPPED CUTTING TOOLS

CHIZHOV, V. N., candidate of technical sciences and STRUSEVICH, V. D.

[Abstract] Increased productivity in the machining of monolithic bushings from wear-resistant cast irons can be realized by using oxide-carbide ceramic. The VOK-60 ceramic was tested against domestic and imported carbide cutters on Nerezist (HB 145-160). The life of the ceramic tools was twice that of K15 GC 315 alloy and four times as great as that of VK6-OM alloy. The best cutting speed was shown to be 240 meters/min. The ceramics also proved superior to T5K10 carbide in machining bushings from chromium-silicon iron (HB 240-280), lasting for 58 pieces as compared with 20 for the carbides.

A CUTTER WITH A MULTIFACE DISPOSABLE CERAMIC INSERT

ALEKSANDROV, P. D., GRIGOR'YEVA, T. S. and MAL'TSEVA, L. D.

[Abstract] Multisided disposable inserts made of VZ and KOV-60 ceramic were used to replace cutting tools using soldered VK6-OM carbide tips for the machining of steel bearing rings on a vertical lathe. Labor productivity was increased by 18 percent, machine time per piece was decreased by 30 percent and cutting edge life was increased by a factor of 2.9. Figures 2.

WEAR RESISTANCE OF TOOLS WITH CERAMIC INSERTS

PAKHOMOV, V. V., BEZRUKOV, A. A., MAL'TSEV, O. S. and YANTSOV, E. M., candidates of technical sciences

[Abstract] The Voronezh Polytechnic Institute compared the wear resistance of cutting ceramics VZ, VOK-60 and VOK-63 with the carbides Tk5K6, VK3-M, VK6-OM and TT8K6. VOK-60 can be used to cut quench-hardened steel at speeds 1.5 times as great as for VZ and 8.8-10 times as high as for V15K6 carbide. VZ ceramic has the shortest life in turning chilled cast iron and annealed VOK-63 the longest, with annealed and unannealed VOK-60 in the middle position. Annealed VOK-63 can be used at a cutting speed 2-3 times that for VZ. The productivity of VOK-63 is 2-2.5 times as high as that of VOK-60, 1.5-2 times as high as that of annealed VOK-60 and 1.3-1.6 times as fast as for unannealed VOK-63. In turning chilled cast iron, practically no initial wear was observed, and afterwards individual small chips and grooves were formed on the cutting edge. These gradually grew until breaking occurred, after which wear stabilized and the cycle was repeated. Formulas for cutting rates in machining chilled cast iron with VZ, VOK-60 and VOK-63 are given. The reasons for wear resistance of the ceramics are: lower oxidizability and immunity to adhesion-diffusion interaction with the material being machined. The ceramics have a lower thermal cycle stability and cyclic strength. Cutting depths over 2 mm and feeds over 0.3 mm/rev with chilled cast iron significantly decrease the wear resistance of the ceramics.

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USE OF CERAMICS IN TURNING

SAMOYLOV, V. S., candidate of technical sciences

[Abstract] The main areas of use of cutting ceramics are finish and semi-finish turning of quench-hardened steels, high-strength and chilled cast iron pieces, and the machining of ceramics. The Orgprimtverdosplav Special Production Technology Office is working on incorporation of the oxide-carbide ceramics VZ and VOK-60. Tool clamping, avoidance of shock loads and handling of chips are important elements in the use of ceramics. A table of cutting conditions for various steels and cast irons is presented.

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CERAMICS IN TOOTH-CUTTING TOOLS

MOYSEYENKO, O. I., candidate of technical sciences, RADZEVICH, S. P. and STOYALOV, V. M.

[Abstract] A promising use of oxide-carbide ceramics is in replacing the grinding of quench-hardened gears by finishing on a hobbing cutter. The Kiev Polytechnical Institute tested various cutting conditions on 18KhNVA steel. Particularly mentioned are a rake angle of $-8°$, a clearance angle of $8°$, an edge angle of $42°$, a cutting speed of 110 m/min, an axial feed of 2.5 mm/rev and a cutting depth of 0.2 mm. The cutting edges lasted 260-280 minutes. The inserts had a chamfer 0.4 mm wide at an angle of $-20°$ to the forward surface. The inserts were cemented with epoxy, with the base and seating surfaces ground to a finish Ra = 0.08-0.16 microns. VOK-60 ceramic was used.

MACHINING OF PIECES WITH CERAMIC TOOLS

SHPIN'KOY, V. A., candidate of technical sciences, GORYACHEV, N. S. and
KALOSHIN, V. V.

[Abstract] The oxide-carbide ceramics recently developed by VNIITS have a
bending strength twice that of TsM 332 oxide ceramic and thus have a greater
range of applications. Tests showed that VOK-60 ceramic had a lower coeffi-
cient of friction with VKS-210 high-strength steel and Kh12F1 quenched steel
than did carbides. VOK-60 had a higher temperature of seizing without de-
struction of the contact zone than did the carbides. The new ceramics have
a lower heat conductivity than carbides and thus are inferior to the latter
in strength. However, the oxide-carbide ceramics have a higher coefficient
of linear expansion then carbides, making it possible to use them without
lubricating and cooling fluid. A graph shows the effect of cutting speed on
the life of ceramic inserts. The new ceramics can cut steel of Rockwell C
hardness 56-62 some 10-15 times as fast as carbides can. The surface finish
of steels machined with the ceramics is unchanged over a wide range of speeds
for hard steels and improves with speed for softer steels. A class 8 finish
can be obtained for both raw and heat-treated steels, although the speed must
be relatively high for softer steels.

The oxide-carbide ceramics can be used for turning interrupted surfaces and
for milling.

Industrial use of the oxide-carbide materials in machining high-strength cast
irons and heat-treated steels gives longer tool life, greater stability and
better surface finish. Steels with hardness below HRC 30 are also machined
industrially at higher speeds. Currently-produced 3- and 4-sided inserts
have an 0.2-0.3 mm chamfer at an angle of 15-20°, which causes problems at
feeds of about 0.1 mm/rev. A decrease in the chamfer width to 0.05 mm
gave good results in turring ShKh15 steel (HRC 62) at a feed of 0.07 mm/rev.
A tip radius of 0.3-0.5 mm gives higher machining precision. Figure 1.

USE OF CERAMICS IN CUTTING OPERATIONS

ANDREYEV, V. N.

[Abstract] The cutting properties of VSh oxide ceramic and VZ oxide-carbide ceramic were compared with those of TsM 332 ceramic and T30K4 and VK2 carbides in the machining of two varieties of steel and two varieties of cast iron. The VSh ceramic proved to be 3-4 times better than the T30K4 carbide and practically the same as the TsM 332, while stability of cutting characteristics was better for the VSh than for TsM 332. In machining 40Kh steel, the VSh ceramic was 1.5-3 times as good as TsM 332, as well as being more stable. In cutting SCh21-40 gray cast iron, VSh ceramic was far superior to VK2 carbide and better than TsM 332 ceramic, with higher stability. Similar results were obtained in intermittent cutting of cast iron. The cutting characteristics of VZ and VSh ceramic were practically the same, except that in intermittent turning of 45 steel the VSh was unsatisfactory. VZ ceramic also proved better than VSh ceramic in turning VCh60-2 high-strength cast iron.

VZ ceramic proved to be particularly effective in machining quench-hardened steels. The Ryazan' Machine Building Plant realized a great improvement in cutting circular threads on screws hardened to HRC 58-60. Cutting with carbide resulted in chipping, vibration and fast tool wear. Fast cutting with VZ ceramic decreased vibration but produced too wide a chip. A tool with two circular inserts solved the problem, once the chip breakers were made at an angle of 30-35° to the cutting edge. Figure 1.

PROSPECTS FOR INCORPORATING TOOLS WITH CERAMIC INSERTS

PUSHMIN, B. M., candidate of technical sciences, and GOSTEVA, G. K.

[Abstract] The introduction of ceramics in metalworking has been delayed by their low strength and inadequate design of inserts and tools. The new ceramics VZ, VOK-60 and VOK-63 are improved varieties. They can double cutting speed while providing 5 .0 times the cutter life and decreasing

labor input of operations by 44 percent. The ceramics have low bending strength and impact strength, which decreases the possible range of feeds. But ceramics currently under development are already approaching the strength of the most wear-resistant carbides, which will make possible a wider range of applications. Other shortcomings of the ceramics are low heat conductivity and low resistance to cyclic changes of heat load, so that cracks may form during intermittent cutting operations. Better tool holders must be developed; in addition new varieties of ceramic must be introduced, the selection must be expanded and high-speed high-rigidity metal cutting equipment must be developed.

EVALUATION OF THE CUTTING PROPERTIES OF METAL CERAMICS

EYKHMANS, E. F., candidate of technical sciences, TSVETKOV, V. V., MAKSIMOV, A. A. and VEPRINTSEV, L. V.

[Abstract] The new varieties of ceramic were tested in transverse and longitudinal turning of grade 50 steel (HB 190-220) and compared with foreign varieties. VZ and VOK-60 were found to be identical in their cutting properties with NPC-A2 produced by Progress Trading (Japan) and SH-1 produced by Feldmuhle (FRG), and better than Feldmuhle's SN-56 and a Swedish variety. VOK-60 was found to be the same in terms of life and stability as CCT-815 ceramic produced by Carborundum (USA), while VZ was somewhat less durable. VOK-60 was somewhat inferior to CCT-815 in terms of surface finish of work, while VZ produced a better finish.

The operating qualities of the ceramics are improved by edge chamfering. VNIITS has developed a special vibration method for this operation. Tests of the effect of radius of curvature on the life of VOK-60 inserts indicated that the faster the feed the larger the radios should be, with a recommended range of 30-40 microns.

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DISPOSABLE CERAMIC TOOL INSERTS

MERKULOV, L. P., candidate of technical sciences, KOSTIN, G. B., ZOLOTAREV, G. R. and ZLENKO, A.A.

[Abstract] Mechanical clamping of cutting tips gives high positioning accuracy, decreases the time required to replace worn edges and increases work time for the tool holder. Ceramic inserts are made in a variety of forms including triangular, square and rhombic plates. Because of the low ultimate bending strength of cutting ceramics, circular plates are useful since they increase the length of the cutting edge in contact with the workpiece. Among other useful shapes which are available are tips with a central hole, tips with a relief angle of 7° for boring tools, and various complex shapes for grooving, chamfering and the like. The details of the machining of disposable ceramic inserts are listed. Figures 3.

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THE EFFECTIVENESS OF EMPLOYING CUTTING CERAMICS

MAL'TSEV, O. S., MERKULOV, L. P., MAMKIN, G. I., PIVOVAROV, M. N. and UGNICH, V. A., candidates of technical sciences

[Abstract] The new oxide-carbide cutting ceramics VZ, VOK-60 and VOK-63, prepared by hot compression molding, surpass tungsten-containing carbides in hardness, wear resistance and oxidation resistance, while being inferior to them in strength. Oxide-carbide ceramics are 1.5-2 times stronger than oxides. They can be used for machining at high speeds (435-1,000 m/min) without lubricating and cooling fluids, withstanding temperature loads on the order of 950-1100° C. The cleanness of the machined surfaces often makes subsequent grinding unnecessary. Ceramic tools can be used with a negative rake angle, allowing use of a 90° cutting wedge. Flank wear in the turning of quench-hardened steels, cast irons, copper-containing alloys and the like is less than for carbides. Cutting rates can be 2.6-3.2 times as fast as for carbides, with a maximum feed of 0.4 mm/rev.

VZ and VOK-60 tips are superior to polycrystalline boron nitride in turning variety 45 Kh quenched steel.

The harder the material being machined and the faster the cutting rate, the greater the superiority of ceramics in terms of wear resistance. Effective cutting depths for cast iron and steel are up to 4 mm, while those for non-ferrous metals and alloys are up to 6 mm. The minimum feed is 0.08-0.2 mm/rev.

Chip breaking and removal are especially important in using cutting ceramics. The experiences of a number of enterprises which replaced carbides with ceramics are described.

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NEW TOOL MATERIALS

VEPRINTSEV, V. I., candidate of technical sciences, Deputy General Director of Soyuztverdosplav Production Association

[Abstract] An important economic task is that of producing more and better high-strength carbides for cutting tools. Among the new developments are high-cobalt alloys containing titanium carbide and vanadium, for cutting refractory tungsten and molybdenum alloys, and alloys containing chromium carbide instead of titanium carbide for cutting high-temperature and high-strength materials. The development of mechanically clamped disposable inserts has led to a number of improvements, including the possibility of applying high-durability coatings to disposable tips. Titanium carbides, nitrides and carbonitrides give service lifetimes up to 3 times that of ordinary tips. Metal ceramics represent an important new development. New materials using nickel and molybdenum in place of tungsten, in combination with titanium carbide and carbonitride, show improved scaling resistance, lower friction and less adhesivity to the material being worked, but are less strong. VNIITS [All-Union Scientific Research Institute of Hard Alloys] is developing tools made from superhard materials such as polycrystalline synthetic diamond, although it is proving difficult to fasten this material into the tool. However, multilayered tips consisting of a layer of polycrystalline diamond or cubic boron nitride on a carbide substrate have shown promise.

BIMETALLIC MATERIALS FOR LARGE DIAMETER PIPELINES

BORISOV, V. P., SHCHENKOVA, I. A., STARCHENKO, YE. G., ZELENTSOV, G. N. and
VINNIKOV, A. G., candidates of technical sciences

[Abstract] The rapid evolution of nuclear energy equipment construction and
the increased unit output of plants has engendered an acute need for large
diameter pipelines. The V-1000 and RBMK-1000 facilities require pipes up to
1200 millimeters in diameter with walls up to 100 millimeters thick. Nuclear
power plant pipelines are exposed to the corrosive effects of the coolant at
high pressure and temperature, great cyclical loads, etc. It is most advan-
tageous to use bimetallic materials with the primary layer consisting of in-
expensive structural steel with thin protective anti-corrosive layer of high-
alloy austenitic steel. Technical requirements imposed on the primary metal
of the pipelines for the above facilities are satisfied by Soviet steel grade
Ni-Mn-Mo-V and steel 22K, which are widely used in nuclear energy machine
construction. Austenitic steel grade 08Kh19N10G2B (type 18-8, additionally
stabilized with niobium) is used as the plating layer. Soviet and Japanese
bimetallic pipes were tested. The base metal was melted in electric arc
furnaces with subsequent vacuum treatment. Comparisons of microhardness were
made. Shear and fracture tests were conducted. Yield stress and fatigue
strength were compared among the different grades and producers. Both Sovi-
et and Japanese steel pipes were found to meet requirements of State Standard
GOST 6032-58 (Method AM). Tables 6; figures 5.
[414-8617]

INTERNAL BEARING UNIT OF TYPE GT-100LMZ GAS-TURBINE PLANTS

AREF'YEV, B. V. and STOLBOV, K. V.

[Abstract] A basic design feature of the GT-100-3 gas turbine plant is its
internal bearing unit which is washed by hot gases at 530°C at a pressure of
7.7 kgf/cm^2. The bearing unit is a cantilever construction suspended on two
projections in the forepart of the cylinder of the low-pressure combustion
chamber. Because it is a complex assembly which operates under severe con-
ditions and contains several independent systems which determine the relia-
bility of the entire plant, it should have an adequate number of degrees of

freedom to promote quiet, unstressed operation at high temperatures and pressures. Experience gained in using the GT-100-3 shows that contact-free coupling between the unit's groove and the "tooth" of the low-pressure compressor cover must be provided during assembly of the gas-turbine plant in order to reduce bearing chatter. Figure 1; references 3 (Russian).
[414-8617]

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